# FLIGHT

The AIRCRAFT ENGINEER AND AIRSHIPS

**First Aeronautical Weekly in the World. Founded January, 1909**

Founder and Editor: STANLEY SPOONER

**A Journal devoted to the Interests, Practice and Progress of Aerial Locomotion and Transport**

OFFICIAL ORGAN OF THE ROYAL AERO CLUB OF THE UNITED KINGDOM

No. 1209. (Vol. XXIV. No. 9.) FEBRUARY 26, 1932 [Weekly, Price 6d. Post Free, 7½d. Abroad, 8d.

*Editorial Offices:* 36, GREAT QUEEN STREET, KINGSWAY, W.C.2
Telephone: (2 lines), Holborn 3211 and 1884.
Telegrams: Truditur, Westcent, London.
Annual Subscription Rates, Post Free.
United Kingdom .. 33*s.* 0*d.* United States .. $8·75.
Other Countries .. 35*s.* 0*d.*


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# EDITORIAL COMMENT

JAPAN has been using aircraft freely to bombard the Chinese positions in the neighbourhood of Shanghai. Details of the fighting sent by correspondents on the spot have been very meagre, but allusions to the use of bombs from the air have been frequent. We are left wondering how it comes about that the forts at Woosung and the entrenchments in the village of Kiangwan have managed to escape complete destruction. Yet the Chinese up to the moment of writing have continued to hold these positions in the face of the most determined assaults by the Japanese infantry and tanks, supported more lately by the fire of ground artillery. We are forced to conclude that the bombing of the Japanese aircraft has been unexpectedly inefficient. In all probability the Japanese force is short of heavy bombers, and it takes a very great number of light or medium bombs to make much impression on a well-entrenched position. The Fairey III F bombers of our own No. 8 (Bomber) Squadron found that they could make very little impression on the stone forts built by the Zeidi Imam in the Hinterland of Aden, and earthworks are harder to demolish than are stone walls. We doubt if the Japanese forces in Shanghai have any aircraft better than, or as good as, the Fairey III F. There has been no mention of their using the Short flying boat which they recently acquired, which could certainly carry a good load of bombs. And then, in bombing as in rifle shooting, it is the aim which matters most. It seems improbable, judging by the results, that the aim of the Japanese air bombers has been very accurate. The chief sufferer from air activities has been the suburb of Chapei, which is a densely populated Chinese quarter. The plight of the wretched inhabitants of Chapei has aroused the pity of the western world, and the bombing of it by the Japanese has forfeited the sympathy felt for them in the first place by most thoughtful people in Europe. If the recent Shanghai fighting were to be taken as typical of the warfare of the future, it would seem that the

**Aerial Bombardment**

bomb from the air is more of a menace to a civil population than it is to a military objective. Fortunately, for the reasons given above, such a conclusion would not be justified.

Nevertheless, the use of aircraft at Shanghai has drawn additional attention to the attitude which may be, or ought to be, taken up towards bomber aircraft by the Disarmament Conference now sitting at Geneva. It may be recalled that Great Britain has made no specific suggestion as regards bomber aircraft, beyond a general acceptance of the Draft Convention as a basis for discussion. This Convention proposes to limit the number and the horse-power of the aircraft possessed by each nation, but makes no discrimination between bombers and other types. The French proposals contemplated a force of heavy bombers at the disposal of the League of Nations, and would limit the size of the bombers possessed by each nation. The American proposals agreed fairly closely with those of Great Britain, while Italy made drastic suggestions, which included the abolition of all bombers. This last proposal was hailed by pacifist idealists, but for the practical purpose of minimising the chance of war and limiting the horrors of war, it went too far to be of much real use.

The wisest course for the League of Nations to follow is not to attempt to forbid too much. If too much is forbidden, that is to say if the agreed restrictions would deprive a belligerent of reasonable rights, the rules will certainly be violated the moment that blood gets hot. On the other hand, restrictions which are based on reason and common sense will probably be observed by all belligerents who retain any vestige of sanity. Certain international laws of war were recognised as ancient and well-established in the days of the Black Prince, and he, like his father, for all their talk about chivalry, was a ruthless believer in the policy of " striking at nerve centres." In other words, if Calais or some other town resisted them too stoutly, they were willing to hang the leading citizens or to let their soldiery loose in the town with permission to sack and slaughter at will. Cromwell did the same in Ireland. We should never think of doing such a thing now. Killing a woman or a child with the bayonet, when the slayer could see the horror and hear the shrieks, would never be tolerated for a moment. But the rulers of the civilised world are seriously considering whether it is permissible for the same sort of thing to be done by a combatant who is some distance up in the air and so is comfortably out of eyeshot and earshot of the outrage. Deliberate bombing of civilian areas should certainly be forbidden, and such a prohibition is so reasonable that there should be no chance of its being disregarded in time of war.

What it is unreasonable to forbid is the bombing of military objectives, and because it is unreasonable, such a restriction would certainly be disregarded, and would therefore bring the whole body of international law as drawn up by the League into contempt. Munition factories are legitimate objectives, just as much as forts are, and it would be futile for the League to forbid aircraft to aim at them. If they are placed in crowded cities, accidents will occur and some civilians will be killed by bombs which miss their aim. No one would dream of building an important fort in the midst of a London suburb. If that were done, it would be the builders who would be responsible for the casualties which would inevitably occur among the civilians living near it. Likewise the onus for evacuating the civilians from the neighbourhood of a munitions factory must rest on the Government of the country in which the factory stands. They cannot protect a factory by surrounding it with civilians and either forbidding or imploring the enemy not to attack it for fear he may hurt the civilians. Such a proceeding is equivalent to driving women in front of advancing infantry in the hope that a chivalrous enemy will not fire on them. Indian mobs have adopted those tactics lately, but they are not legitimate warfare.

It may sound paradoxical, but every advance in the accuracy of bombing, as of artillery fire, is to the advantage of the civilian population. If the League of Nations were to prohibit the possession of bomber aircraft in time of peace, that would not prevent civil machines from being used as night bombers in time of war. As day bombers they would be unable to defend themselves until modified to accommodate rear gunners, but they could be used at night, when darkness gives better protection than a gunner can give. They would, however, be very amateurish bombers. The crews would be quite untrained in the art of hitting a target from a moving platform. That always takes a lot of practice, and improvement depends partly on continuous practice and partly on the development of more accurate bomb sights and other instruments. The better the aim of the bomber, the fewer will be the civilians who will suffer. It might be said that we, as a nation, could better survive the violent deaths of a few hundred civilians than the complete destruction of, say, the Bank of England, which would not be an unreasonable objective for an enemy bomber; also that we could better spare 100 civilians than 100 soldiers. The object of the League should be, none the less, to protect the civilian rather than the vital interests of a belligerent nation. Even those who may sympathise with China in the present conflict would have preferred that the Japanese bombs should have damaged forts and killed soldiers rather than fall among the hapless civilians of Chapei.

The League will be grasping the shadow, not the substance, if it attempts to prohibit all bombing from the air. Such a line of policy will not prevent bombing from taking place in time of war, but it will make the bombing less dangerous to the arsenals and more dangerous to the civilians. It will also encourage the combatants to think that all rules of the League are sentimental nonsense which can be disregarded by hard-headed soldiers. If they come to think that, they will certainly act on their thought. To restrict bombing to military objectives, and to educate the opinion of the world to see that such a restriction is reasonable, that is a line of advance which would be of real service to the world, and there is every reason to believe that such a rule would be more strictly obeyed in the next war than it was in the last. Yet even in the great war both sides always admitted the principle of the military objective, even though some airmen were criminally careless as to what was actually below when they pulled their bomb-levers.

Sqd. Ldr. Oswald Robert Gayford, D.F.C., Chief Pilot of the Fairey Long-Range Monoplane. (Flight *Photo.*)

# Cranwell-Capetown Flight

*At the time of going to press the long-range monoplane is at Cranwell ready to start for Capetown. The weather has been unfavourable both locally and in North Africa. A start may be made in the next few days; otherwise it will be postponed for a month*

Flt. Lt. David Lindsay Gordon Bett, Second Pilot of the Machine. (Flight *Photo.*)

The Fairey (Napier) long-range monoplane has already been described in Flight. It is not appreciably different from the former monoplane in which the late Sqd. Ldr. Jones Williams and Flt. Lt. Jenkins flew non-stop from Cranwell to Karachi in April, 1929, and in which they crashed on a mountain near Tunis in December, 1929. As a result of the lessons taught by that crash, the instrument equipment of the machine has been improved. Three altimeters have been fitted, so that there should be no danger of the pilots flying into a mountain in bad visibility through thinking that they were higher up than they really were. Perhaps the chief improvement is the installation of the automatic pilot, a gyroscopic device which keeps a machine on a set course in all conditions of visibility. If the machine swings off its course the automatic pilot brings it back more quickly and more accurately than a human pilot is able to do. It has been thoroughly tested by units of the Royal Air Force, notably by No. 7 (Bomber) Squadron, which will fearlessly fly its "Virginias" in formation into a cloud bank, when other squadrons would not dare to run the risk of collision by doing so. The only drawback of the device seems to be that it corrects too suddenly for comfort in bumpy weather.

Over 1,000 gallons of petrol will be carried in the tanks in the wings. The all-up weight of the machine on this flight is about 17,000 lb., which is an increase of 1,000 lb. on the weight of the former machine on the Karachi flight. The "Lion" engine gives 530 h.p. Its carburettors have been tuned for economy, and slightly larger compression ratio pistons have been fitted.

The machine is a pure cantilever monoplane. The plane varies throughout its span in thickness, chord and incidence. It has a very high lift coefficient, and there is no sudden stall after the angle of maximum lift has been reached.

The tail is also a cantilever, the only external bracing wires on the machine being those to support the fin. Some previous types of cantilever monoplane which have not been covered with wood or metal have experienced trouble from the wing twisting when aileron has been used. In this Fairey machine torsion of the wing is obviated by special patented internal bracing.

The undercarriage is of normal type, with a very wide track. The wheels and tyres are of a specially strong type. The wheels are mounted on roller bearings, to assist the take-off, and are faired with metal "spats."

The main dimensions are:—Span, 82 ft.; length, 48½ ft.; chord at centre line, 16 ft.; mean chord, 11 ft.; height, 12 ft. The cabin is totally enclosed, and windscreen wipers have been fitted. These worked very satisfactorily during the flight to Karachi in 1929. All the windows are triplex, and can be opened for ventilation. The navigator can look downward through the wings and through windows in the side of the cabin. A drift sight can be fitted in the floor, and a hatch in the roof allows the taking of sextant and compass bearings to check the course. A deck lounge chair is provided for the reserve man, and a folding table is also fitted. The provisions to be taken are what were shown to be most suitable on the flight to Karachi. They include two chickens, sandwiches, chocolate, oranges (4 doz.), apples, bananas, dry dates, dry figs, dry raisins, lump sugar, barley sugar, chewing gum, sweets, black coffee (eight quarts) and Horlick's milk tablets.

The aircraft is fitted with a short-wave W/T transmitting


The Fairey (Napier) Long-Range Monoplane taxying at Cranwell before the Flight to Egypt. (Flight *Photo.*)

set, and will report position every two hours through the flight, on a 33.71 metres wave length. It has no receiving set. The Air Ministry has made a special appeal to private wireless stations to refrain from transmitting on the above-mentioned wave length, as they might cause jamming and prevent the receipt of an urgent message.

### The Crew

Sqd. Ldr. O. R. Gayford, D.F.C., has had a good deal of experience of flying work in Africa, for, when serving with No. 47 (Bomber) Squadron, he commanded the R.A.F. flight of 1928 from Cairo to Capetown. He has also made a tour of the West African Colonies to inspect sites for aerodromes and seaplane bases. His service career started when he enlisted in the R.N.V.R. in August, 1914. Later he became an observer and served in the Ægean until the Armistice. He then saw service, still as an observer, with No. 221 Squadron in the Caspian against the Bolsheviks, and, as a staff officer, in Somaliland against the Mad Mullah. In 1920 he went to No. 1 Flying Training School as Adjutant, and learnt to fly. Two years later he saw more of the Near East, when he went to Constantinople as staff officer at the time of the Chanak crisis. Service in Iraq followed, and he saw more active service there. Then he went to No. 47 B.S., as narrated above. In 1930 he passed through the Staff College at Andover, and last October he made a non-stop flight to Egypt in the Fairey monoplane, accompanied by Flt. Lt. Bett. Sqn. Ldr. Gayford is 39 years of age.

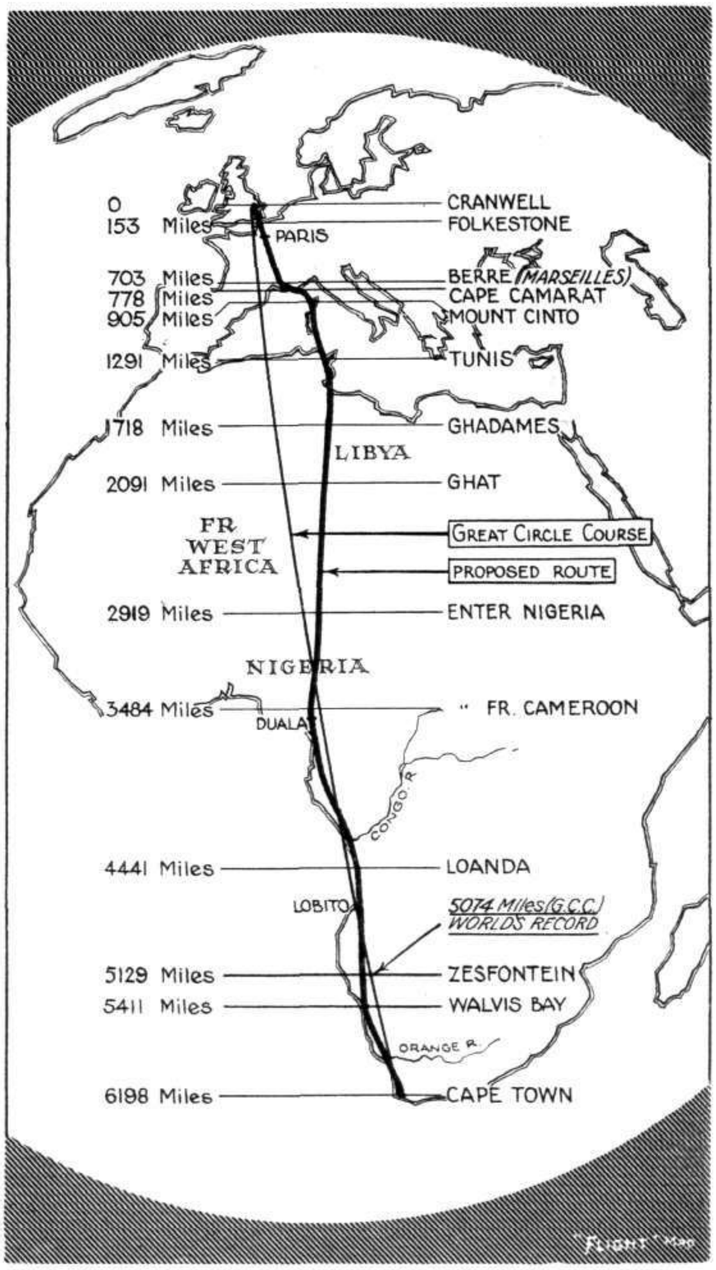
Flt. Lt. D. L. G. Bett is 30 years of age, and, like his companion, he is a Suffolk man. He gained his commission through Cranwell in 1922. After a period with the Communications Squadron at Kenley, he joined Sqn. Ldr. (then Flt. Lt.) Gayford in No. 47 B.S. in Egypt, and was one of the pilots who accompanied Air Commodore Samson in the 1927 flight to the Cape. Recently he has been in charge of the engine research flight at Farnborough.

### The Route to the Cape

The world's record for a non-stop long-distance flight is 5,012 miles (8,065.736 kilometres). This is the distance between New York and Constantinople, and this record was established on July 27-29, 1931, by the American airmen, Boardman and Polando. This record stands until it is beaten by at least 100 kilometres. The records are measured on the great circle course, without regard to the actual mileage covered. Starting from Cranwell, the monoplane must reach a point near Zesfontein, in British South-West Africa, in order to win the world's record. This place is roughly 150 miles south of the Cunene River, and is about 5,129 miles from Cranwell by the course marked out. Obviously the projected course had to follow the great circle course between Cranwell and Capetown as closely as possible, or valuable fuel would be wasted on miles for which no credit would be given. At the same time, it was desirable to avoid the worst of the mountainous country, especially while the machine was still heavily weighted with petrol. It might be necessary to climb to 6,000 feet over the mountains of Corsica and Sardinia, but the route was drawn so as to avoid the *massif* of the Atlas range in Tunisia, where the earlier monoplane crashed, and also the Ahaggar plateau in the centre of the Sahara. The intention is that the machine should reach Tunis about dusk on the day of the start, and the first night should be spent flying over the Sahara. Over the desert it should probably be sufficient to set the automatic pilot on its course and relax after the strain of the start and the difficulties of the early stages over Europe, but. in order to assist, the French authorities very sportingly agreed to light up their landing grounds for 300 miles south of Tunis. By dusk of the second day the monoplane is due to be over Nigeria, and not far from the Atlantic coast near Mount Cameroon. Dawn on the third day should find it over Portuguese Angola. It should reach Capetown before midnight that day.

The details of the route as planned are as follows. After leaving Cranwell the machine would pass over Cambridge and Chelmsford, cross the mouth of the Thames five miles south-west of Southend, and cross the English Channel nine miles south-west of Folkestone—distance from Cranwell, 153 miles.

Enter France near the mouth of the Somme, about 13 miles north of Le Treport, pass over Beauvais and Paris, and fly 35 miles west of Lyon to Berre, near Marseilles—distance covered, 703 miles.

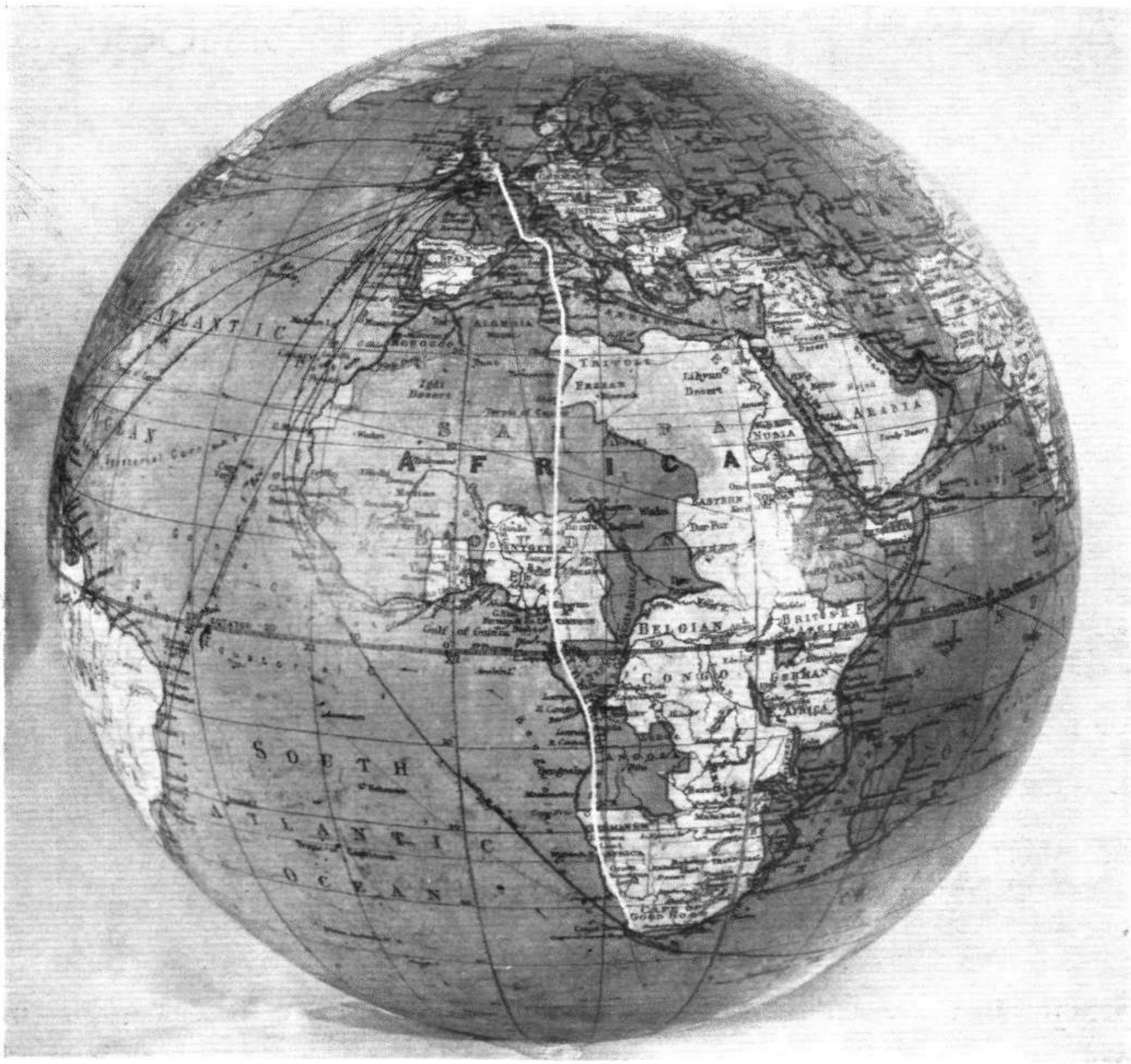



**The photograph of the globe on page 169 gives a true idea of the great circle route from Cranwell to Capetown and of the course marked out for the monoplane to follow. As, however, it would not be possible to mark the names of the places which will be passed on the globe without causing confusion, we have also prepared the above key map on which the progress of the machine can be clearly followed.** (Flight *copyright.*)

At Berre the machine will change course to the east, pass 14 miles north-east of Toulon, leave France at Cape Camarat, about 20 miles south-west of St. Raphael—778 miles.

The machine will then change course again to the south, cross the Ligurian Sea, enter Corsica at Calvi, head for Mount Cinto—905 miles. At Mount Cinto change course again, pass over Corte, leave Corsica at the Gulf de Porto Vecchio, cross the Strait of Bonifacio, enter Sardinia over Maddalen Island, pass over Terranova, leave Sardinia at Cape Ferrato near the south-east corner, cross the Mediterranean, and enter Tunisia at Ras Zebib, nine miles east of Bizerte, for Tunis—1,291 miles.

At Tunis the pilots will change course again, cross the Gulf of Gabes, enter Libya 40 miles north-east of Ghadames and 427 miles from Tunis—distance 1,718 miles. Fly 373 miles over Libya—2,091 miles. Enter French West Africa 20 miles north-west of Ghat and 50 miles north-east of Fort Charlet. The distance across French West Africa is 828 miles, bringing the total from Cranwell up to 2,919 miles. Enter Nigeria at Karguiri, pass over Bauchi, cross the Benue River (a tributary of the Niger) at Ibi. Fly 237 miles and enter French Cameroon. The distance across Nigeria is 565 miles, bringing the total up to 3,484 miles.




**On the globe shown above the great circle course is shown by a thin straight line, and the course marked out for the flight by a broad white one. The chief deviations of the course from the great circle route are due to the desire to fly well clear of the Atlas Range in Northern Africa and the Ahaggar Plateau in the Central Sahara. The course for the flight is only some 138 miles longer than the great circle route, the distances being 6,198 and 6,060 miles respectively.** (FLIGHT *Photo.*)

Cross the River Kamp into Rio Muni (or Spanish Guinea), enter French Equatorial Africa 96 miles farther on, and cross River Ogwe nine miles north-east of Njole; thence across River Kwilu and fly to Kabinda in Portuguese territory, crossing the mouth of the Congo into Angola, and then to Loanda—4,441 miles.

Change course again at Loanda, proceed to Lobito, and thence to a point 450 miles farther on near Zesfontein, in British South-West Africa, which is 5,074 miles from Cranwell over the great circle course. On crossing a line running east-west through this point, the machine will have broken the record. It is about 5,129 miles from Cranwell.

Fly to Walvis Bay, 5,411 miles from Cranwell, and change course there. Cross the mouth of the Orange River 400 miles on, and fly via Cape St. Martin to Capetown—total distance, 6,198 miles.

The mileage given above does not allow for deviations from the course marked out. Two such deviations will occur on the stretches between Loanda and Lobito, and between the Orange River and Cape. St. Martin, where the machine will not fly by the most direct route across the sea, but will follow the coast.

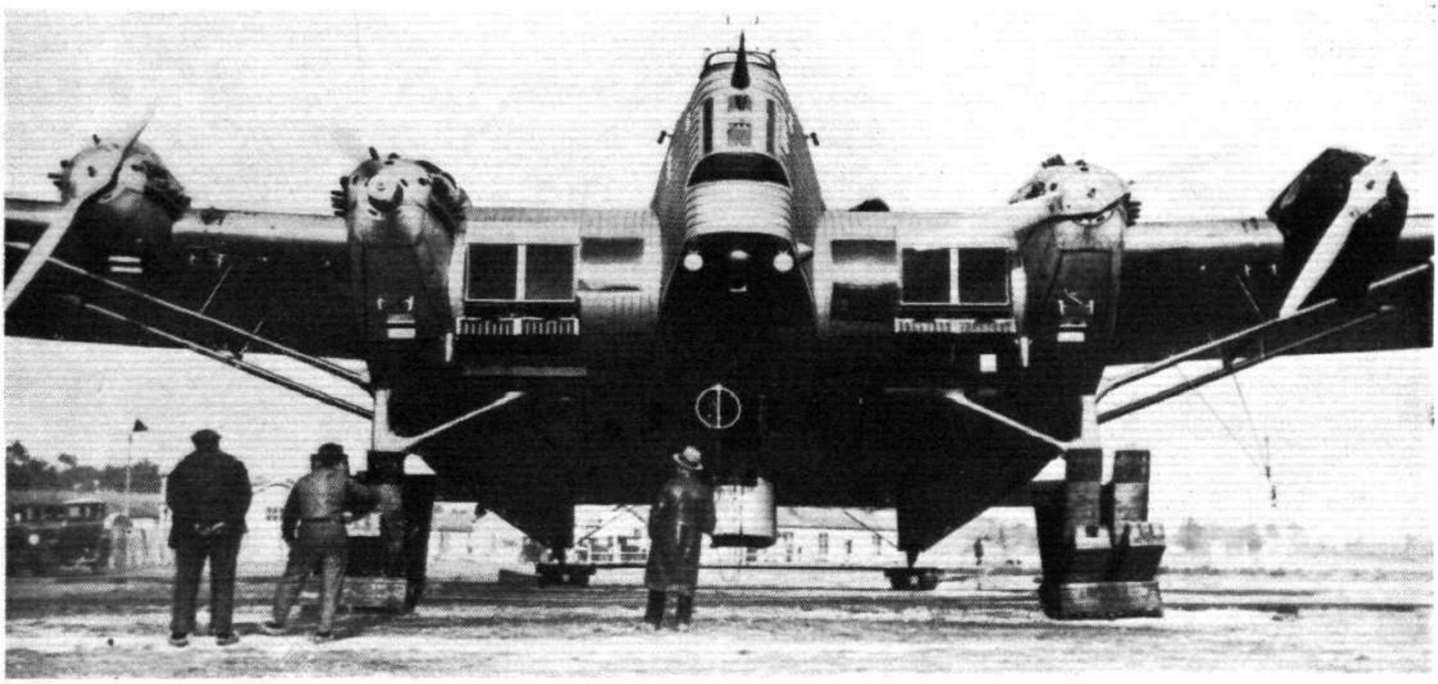
### The Flight to Egypt

The monoplane, with its two pilots, made a trial flight non-stop to Egypt on October 27-28, 1931. It left Cranwell early. There was no wind, and the machine took off without difficulty—it was comparatively lightly loaded with fuel. The weather was foggy until some way south of the Thames, then good until 100 miles south of Paris, when low clouds continued up to the Mediterranean. The pilots flew above the clouds until near the sea, when they dived down to check position. The base of the clouds was 2,000 ft. It was raining heavily and the wind was due east. They climbed to 9,000 ft. so as to clear the mountains of Corsica and Sardinia during the night. Nothing was seen during the night except occasional lights through rifts in the clouds. Another cloud bank up above obscured the stars. During the night the wind changed round from east to west, and the machine was carried to the east of its course. Before dawn its position was discovered, and course was altered to make landfall well down the Gulf of Syrtis. Then good weather was found, and the machine reached Abu Sueir and landed 31 hours after leaving Cranwell. The pilots did not sleep, but were not unduly tired.

The machine was delayed in Egypt for some time by bad weather. It came back by easy stages, but after reaching England it was forced to land by bad weather, came down in a ploughed field, and was slightly damaged. It was repaired at the Fairey works and overhauled so far as was thought desirable

# A New French Night Bomber

*The "All-wing" type of Aircraft visualised by Professor Junkers many years ago has not yet materialised, but several attempts have been made from time to time to secure some of the advantages by having a central body deep enough to house most of the load carried, and of sufficient area to act as a lifting surface. The Burnelli machines are a case in point, and now the French Company Société Aerienne Bordelaise of Bordeaux has produced a night bomber incorporating somewhat similar principles*



**NEW FRENCH NIGHT BOMBER: The A.B. 20 is a four-engined development of the three-engined commercial typ D.B. 70. The engines are Lorraine "Courlis" of 600 h.p. each.**

DEVELOPED from the Dyle et Bacalan D.B.70 commercial machine by the Société Aerienne Bordelaise of Bordeaux, the A.B.20 shown in the accompanying illustration is a night bomber fitted with four Lorraine "Courlis" engines of 600 h.p. each, giving the machine a total power of 2,400 h.p. The design is unusual, in that the central portion of the wing has been greatly thickened to give space for crew, bomb load, fuel tanks, etc. In this respect the A.B.20 resembles somewhat the American Burnelli machines, which represent a compromise between the "all-wing" machine and the more orthodox types.

The A.B.20 was actually begun as a three-engined machine, like its prototype the D.B.70, but the French technical services then decided that they would like the central forward part of the body to be capable of taking a gunner's cockpit, and the design was subsequently modified into a four-engined type, the engines being placed abreast, two in the noses of the fuselages, and the other two in faired nacelles in the leading edge of the wings. One result of thus "changing horses in mid-stream" has been that the machine has come out heavier than expected—to the extent of about 1,000 lb.—but if another machine is built the designers are confident that they will be able to save this weight.

The A.B.20 is of all-metal construction, and has a gross weight of some 13,500 kg. (29,700 lb.). The central body has large bomb accommodation—at least up to a total bomb load of 2,500 kg. (5,500 lb.). Normally it is intended that the machine should have a range of 600 miles, when the bomb load is about 4,400 lb. The forward part of the central body is built out as a cabin for the navigator and bomber, and in the upper part of it is a gunner's cockpit with swivelling gun ring, etc. Farther aft, and also on top of the central body, is another gunner's position, while a third is situated underneath the body in a sort of gun turret, which can be raised and lowered.

The wing span of the A.B.20 is 37 m. (121 ft.), and the wing area 206 m². (2,220 sq. ft.). Of this the central body has an area of 947 sq. ft. The estimated top speed is 215 km./h. (133 m.p.h.), and the cruising speed 195 km./h. (120 m.p.h.). This is at an altitude of 11,500 ft. The theoretical ceiling is 21,300 ft.

**At Buckingham Palace**

At the Investiture held by H.M. the King at Buckingham Palace, on February 23, those invested by His Majesty with the Insignia of the Orders into which they have been admitted included:—

*Order of the Bath (Military Division).*

Companion:—Air Com. Henry Brock, R.A.F.

His Majesty also conferred decorations as follows:—

*Bar to the Distinguished Flying Cross.*

Sqd. Ldr. Oliver Bryson, R.A.F.

*The Distinguished Flying Cross.*

Flt. Lt. Charles Hancock, R.A.F.; F/O. Sidney Carr, R.A.F.; and F/O. Geoffrey Monk, R.A.F.

*The Air Force Cross.*

Sqd. Ldr. Gerald Livock, R.A.F.; Flt. Lt. Edward Colbeck Davis, R.A.F.; Flt. Lt. William Johnson, R.A.F.; F/O. Peter Cracroft, R.A.F.; and Mr. Charles Scott.

# THE PRATT & WHITNEY FUEL INJECTION SYSTEM

FURTHER details of the direct fuel injection system evolved by the engineers of the Pratt & Whitney Aircraft Company, of East Hartford, Connecticut, U.S.A., are now to hand. In our issue of January 8, 1932, we published brief particulars of this system, but the following notes will help to explain the details of the layout. The system has, as already announced, been put into flight test service on a Hornet engine installed in a Boeing 40-B-2 mail plane on the Boeing Division of the United Airlines. This system provides for the direct injection of atomised fuel into the cylinders, and eliminates the necessity for a carburettor, pre-heaters, and hot spots.

In order to put the system into operation with the least possible change in basic design of the existing models, the carburettor and hot spot are replaced by an air valve which is bolted directly to the flange of the carburettor elbow on the rear crankcase section. This valve is for the purpose of controlling the amount of air entering the cylinders at all speeds from idle to full throttle. It is a simple butterfly type valve, provided with means for varying the amount of fuel and air for the purpose of leaning out the mixture at high altitudes. This valve is made of an aluminium casting, and the necessary control levers are mounted directly on one side of it.

The fuel injection pumps are contained in a special crankcase front-section casting, which replaces the standard front section. They are arranged radially just forward of the usual valve tappets. The pump-actuating mechanism consists of a special four-lobe cam, which is carried on the forward face of the cylinder valve operating cam, the latter being similar in design to the standard valve-operating cam. This whole assembly is carried on an extension of the crankshaft thrust bearing retainer.

The fuel injection hammers are carried in special guides in the crankcase front section. They are provided with springs which seat against the cam bearing support. A special stop cam having nine lobes, one for each hammer, is arranged concentrically around the hammers and restrains their movement for the purpose of controlling the length of stroke of the injection pumps. This control cam is moved rotatively by a rack and pinion connected to linkage on the outside of the crankcase, which in turn is connected to the air valve on the rear section.

The injection pumps are mounted directly in line with the injection hammers and approximately on the centreline of each cylinder. They are made up of duralumin forgings which form the body and a pump plunger with suitable packings which provide a tight seal and freedom from scoring when using petrol as a fuel. The pump plungers have on their innermost ends flanges which engage in slots in the injection hammers.

The pump cylinders are provided with inlet and outlet valves arranged so there is no serious trapping of air in the cylinders ahead of the pump plungers.

The fuel injection nozzles are simple in form, designed to require a minimum of attention, and are located in the front of the cylinder heads immediately above the spark plugs. They are connected to the pumps by means of steel pipes of uniform length for each cylinder.

The fuel supply system consists of a standard fuel pump, the same as used with the carburettor and mounted in the same location. This pump delivers fuel to the underside of a circular manifold, which is made of steel and securely fastened directly to a connection on each of the nine fuel pump cylinders. Suitable screens are provided in this manifold, arranged concentrically around the inlet port to each injection cylinder. This manifold is especially designed to carry off any entrapped air which may find its way in with the fuel. The excess fuel supplied by the main fuel feed pump and entrapped air is carried off through a fuel pressure relief valve at the top of the manifold and is returned directly to the main fuel supply tank.

The general method of operation of the injection pumps is as follows: The fuel pump hammers are provided with shoes which engage four lobes of the pump operating cam. These cams draw the hammers inward toward the axis of the crankshaft. The cams are so arranged that the hammers are drawn back slowly in order to permit the flow of fuel into the pump cylinders at a normal slow rate. Their contour is such that they overrun a sharp edge on the shoe, permitting the springs which have been compressed by the inward movement of the hammers to return the hammers with a rapid movement. Clearance is provided between the heads of the hammers and the heads of the injection pistons and arranged in such a manner that a sharp hammer blow is imparted to the piston, assisting in the fine atomisation of the fuel. The pressure of fuel discharge can be regulated by the adjustment of the springs which control the hammers and injection valves. The hammers are restrained from their outward movement by the nine-lobe cam previously referred to, which is operated by the rack and pinion, which in turn is interlinked with the throttle valve. The adjustment on this control cam is sufficient completely to cut off the pump stroke if desired and on the opposite end of the travel provides sufficient stroke for full throttle operation. Because of this particular design, there can be no overtravel of the pump plungers, which, together with the sharp cut-off, prevents after-dribbling of the injection nozzles. This special feature has been made the subject of patents granted to Stephen A. Hasbrouck, one of the company engineers.

The linkage between the injection pumps and the air valve is such that proper proportioning of air and fuel may be had at all speeds from idle to full throttle at sea level or at any altitude between sea level and the maximum altitude to which the aeroplane can fly. This linkage is so designed that full opening of the air valve may be had at any given altitude.

The pilot's controls are similar to the standard controls and designed to mount interchangeably in place of the standard control quadrant. They consist of a lever which is connected to the linkage on the air valve controlling the injection pump stroke and metering of air with the one lever. The usual mixture control lever is replaced with a similar one, which varies the setting of the pump stroke with respect to the air valve and does not interfere with the free movement of the main control lever. A third lever is connected in the usual manner to the magneto advance and retard mechanism, inasmuch as with this system magnetos and spark plugs are employed as in the conventional engine with carburettor. The controls, therefore, being arranged and operated in a standard manner, do not tend to confuse the pilot who is used to flying a standard engine.

Starting, idling and acceleration are improved, inasmuch as the fuel is injected directly into the cylinders. Starting is carried out in the conventional manner.

Because of the fact that the entire air induction system, from the air valve through the supercharger and inlet pipes to the cylinders does not contain any combustible mixture, fires, resulting from a backfire, are avoided, since flame does not find its way out of the air scoop and there is no fuel present at this point.

The necessity for pre-heaters and hot spots is entirely eliminated in that there is no requirement for heat at the point of the air valve for the vaporisation of the fuel as with the carburettor. The only heat at all necessary is a sufficient amount to prevent the bearings of the throttle valve or the valve itself from being frozen in a fixed position, and to date it has been found that the normal temperature of the crankcase sections at this point have been sufficient to prevent any necessity for additional heat.

Engines equipped with this system of fuel injection have not yet been put in general production, as, in accordance with the fixed policy of the Pratt & Whitney Aircraft Company, the device must first be submitted to a rigid service flight test. Changes and modifications will undoubtedly be found desirable, as a result of these service tests. Engines of this type will not be made available for general sale until such time as they have definitely demonstrated through service use the superiority of this system over the present method of carburation.

This development has been going on for a considerable period of time at the company's plant at East Hartford, Connecticut, during which time several hundreds of hours have been accumulated on the experimental engines in both flight and bench tests. This running has involved several standard 50-hour tests and one test for a duration of 300 hours. Department of Commerce tests have been successfully passed.

While the development to date has been based on the use of petrol as a fuel, heavier and less inflammable fuels may eventually be used with modifications to the system and the cylinder with which it is fitted.

An engine has already been flown on furnace oil to determine the possibilities along this line of development.

# A CO-OPERATIVE TRAINING SCHEME

THE complaint has often been made, and certainly with some justification, that there is too little recognition of the men who perform the spade-work in the aircraft industry, namely, the draughtsmen and the fitters. In the years following the Great War, when the industry was fighting for existence, the life of these men could be compared to the life of an Arab tribe—nomadic.

Draughtsmen in particular were the victims of this wandering life. You could always recognise them when they broke camp and moved on by the symbol of their occupation—the T-square—tucked under their arm. The opportunities of bringing that symbol before the public eye were, we suspect, something like compensation to them! Perhaps to the single men the constant changes were also in the nature of mild adventures, for drawing to dimensions is a prosaic job, but to the married men the changes meant a burden of expense and domestic worry.

Even the best or most favoured of employees found that their chief mental preoccupation was wondering how long the job was going to last. Only the love of the work or the plight of the engineering industry generally kept them faithful to aircraft work. In those early struggling post-war years firms had the greatest difficulty in finding men with aircraft experience, especially for the drawing office, and it became necessary to rely upon men skilled in other branches of engineering.

In some aircraft drawing offices 90 per cent. of the men came from shipbuilding firms, which were then practically stagnant. On the whole these draughtsmen adapted themselves to aircraft design very quickly, and many of them are still established in the industry, occupying the posts of "leading hands."

### Brough Training Scheme

To-day, roughly twelve years later, aircraft firms are able to find a percentage of young men who have completed their apprenticeship in the aircraft industry, but in spite of this there are still complaints from a few quarters about the difficulty of finding adequately trained men. This difficulty is responsible for a co-operative training scheme inaugurated by the Blackburn Aeroplane Co., Ltd., the University College of Hull, and the Municipal Technical College of Hull. It is a scheme by which the Blackburn Aeroplane Co., Ltd., will take a limited number of apprentices, and thus provide them with a sound practical experience in the workshops and the drawing office.

The whole training period will last four years and nine months. The first two years will be spent in the works at Brough, near Hull, and the next two at whole-time study at the University College and the Municipal Technical College. For the remaining nine months the students will obtain drawing office experience at Brough. During the two years' workshop practice at Brough they will have to attend evening classes at a technical school and reach the standard necessary for seeking admission to the College. The minimum age set for such admission is 18 years. Resulting from their workshop experience and attendance at a technical evening school, students are recommended to take the National Certificates of the Institute of Mechanical Engineering to fortify their application for the College course of two years. At the end of this course, which includes training in mathematics and physics at the University College and further practical experience in the engineering shops of the Municipal Technical College, the student should be able to qualify for the Diploma granted by University College.

The development of this training scheme, combined with the opportunity of obtaining actual flying experience at the N.F.S. Club at Hedon, where the municipal aerodrome for Hull is established, makes the East Riding of Yorkshire a finely-equipped training centre for the youth with ambitions in the aircraft industry. Moreover, as long as the empty bulk of the airship sheds is a landmark on the flat fields of Howden nearby, there is always a chance that one day the vast bulk of a new airship will emerge into the daylight and provide the local student with another phase of aeronautics for study.

Students who are interested in this scheme can probably obtain further details from the Municipal Technical College, Hull.

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# THE ROYAL AERO CLUB OF THE UNITED KINGDOM

IN the Report of the Meeting of the Committee of the Royal Aero Club, held on February 10, published in last week's issue of FLIGHT, the following list of Aviators' Certificates was unavoidably crowded out:—

| | | |
|---|---|---|
| 10304 | John P. Early.. .. | Hanworth C. (N.F.S.). |
| 10305 | Kenneth G. Vandyck.. | Brooklands Fl. School. |
| 10306 | Cyril E. Berens .. | Wiltshire Light Ae. and Country C. |
| 10307 | Alexander A. D. La Touche | Yorkshire Ae. C. |
| 10308 | Thomas H. Forrest .. | Brooklands Fl. School. |
| 10309 | Patrick T. S. King .. | London Ae. C. |
| 10310 | Russell W. Pratt .. | Air Service Training, Ltd. |
| 10311 | J. Grover .. .. | Marshalls Fl. C. |
| 10312 | Thomas Bata .. .. | De Havilland Fl. School. |
| 10313 | Kristiam Haldorsen .. | Brooklands Fl. C. |
| 10314 | Evelyn M. Jackaman.. | Airwork Fl. School. |
| 10315 | Robert E. Lowe .. | Northern Air Lines. |
| 10316 | John M. Wintour .. | Hanworth C. (N.F.S.). |
| 10317 | Peter R. Simpson .. | Hanworth C. (N.F.S.). |
| 10318 | Beatrice M. Neison .. | Do. do. |
| 10319 | Oliver L. L. Fitz-williams .. .. | Do. do. |
| 10320 | Ronald D. Gerrans .. | Marshalls Fl. School. |
| 10321 | Frank Lodge .. .. | Yorkshire Ae. C. |
| 10322 | Norman H. R. Wardle | Hampshire Ae. C. |
| 10323 | Gilbert I. Pawson .. | Brooklands Fl. School. |
| 10324 | Hugh Miller .. .. | Hanworth C. (N.F.S.). |
| 10325 | John H. Davis .. | Do. do. |
| 10326 | Jack G. Marshall .. | Do. do. |
| 10327 | Susan A. R. Tilney .. | Do. do. |
| 10328 | Umberto A. Combi .. | London Ae. C. |
| 10329 | Herbert S. Brown .. | Kuala Lumpur Fl. C. |
| 10330 | Fergus B. Taylor .. | Do. do. |
| 10331 | Harold B. Hinton .. | London Ae. C. |
| 10332 | Editha I. H. Dargel .. | Hampshire Ae. C. |
| 10333 | Arthur N. Wilson .. | Liverpool & Dist. Ae. C. |
| 10334 | Ronald Ellison .. | Hanworth C. (N.F.S.). |
| 10335 | Percy S. Papps .. | Hampshire Ae. C. |

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**The Disarmament Conference**

ON February 21 the British Delegation to the Disarmament Conference handed in the British proposals.

It is suggested that the following questions be closely studied:—

(1) Limitation of effectives. (2) Prohibition of mobile guns beyond a certain calibre. (3) Abolition of submarines. (4) Limitation or reduction in the size of warships and the calibre of their guns. (5) The examination of the problem of aerial bombing. (6) The abolition of gas and bacteriological warfare; and (7) The establishment of a permanent Disarmament Commission.

The Japanese proposals have also been handed in. The main points are:—The limitation or reduction of air forces, to be executed in a manner that will rectify existing inequalities among the air forces of the Powers. Prohibition of aerial bombardments of cities and towns, as well as other aerial attacks on civilians. Prohibition of scientific bacteriological warfare. Reduction of the tonnage of capital ships and the calibre of guns. Reduction of the tonnage of aircraft carriers permitted under present treaties. The prohibition of aeroplane landing decks on vessels that are not aircraft carriers. The entire abolition of aircraft carriers after the suggestion in the previous point has been brought into effect. Strict limitation of armaments on merchant ships and aircraft.

# PRIVATE FLYING & GLIDING

## THE MESSENGERS' FLYING CLUB

Three members of the Flying Club formed by the uniformed messenger boys of the Commercial Cable Co. are now qualifying for their pilots' licences on three totally different types of aircraft. One is learning on an ordinary aeroplane, another is on the autogiro and a third is learning the art of soaring flight on a sailplane.

The British Air Transport Co., Ltd., of Croydon Aerodrome, offered to give a scholarship to a selected member, and Messenger 160, R. McDonald, has already been selected for this. He is now on daily flying duty at Croydon Aerodrome, where he is being fully trained as a pilot.

Messenger 161, R. Cable, is being given the same facilities by the Cierva Autogiro Co., and he is starting immediately to be trained at Hanworth as an autogiro pilot.

Messenger 132, E. Northwood, is being put through a complete course of gliding by the London Gliding Club at Tottenhoe.

Every week a party of messengers visit the various aerodromes, the members being taken up for flights by prominent pilots. The British Air Transport Co. took 40 boys up one day. The Hon. Mrs. Victor Bruce has taken 12. Others who have given their services are Capt. Rhodes, of Shell B.P., the Master of Sempill, Mr. A. C. Brie, of the Autogiro Co., and Flt. Lt. N. Russell, of the Redwing Aircraft Co.

Thus, within six weeks of the formation of the Club, over 50 messengers have flown and three are already being trained as pilots.

Mr. Geoffrey Dorman has mainly been responsible for forming the Club, and the Hon. Mrs. Victor Bruce is Vice-President of the Club.

Among forthcoming events are a flight in the late Lt. Com. Glen Kidston's aeroplane, in which he broke the record from London to Capetown, and lectures by Mr. Bert Hinkler, Wing Com. A. H. Orlebar and other famous pilots.

A summer camp is being arranged for August at the Hanworth Air Park, at which messengers will be able to get in plenty of flying. One of the objects of the Club is to make the boys thoroughly familiar with aircraft of all kinds, so that when their time as messengers is over they will be eligible to enter the aircraft industry or the Royal Air Force.

## NOTTINGHAM FLYING CLUB

During 1931 the membership has increased to 110, the number of flying members still being very much in the majority; "A" licences now total 45. The number of private owners has grown to 10 and the total flying time was approximately 2,000 hr., the two Club machines being responsible for 950 hr. It is interesting to note there has been only one forced landing due to mechanical defect, in fact, this was the first forced landing since N.F.S. took over the Club in September, 1929, and it proves the efficiency of N.F.S. staff and organisation. In the case mentioned the defect was remedied on the spot and the machine completed the journey.

Cross-country flying has been most popular and successful during the year. It is almost impossible to mention a civil aerodrome in the country which has not been visited by a machine from Nottingham. One private owner and friend flew to Dublin and back.

The Grainger Bros. have made numerous successful flights in their tailless machine the "Archæopteryx," which shows great promise. A further interest to the Club is the experimental work being carried out by Rolls Royce, Ltd., who have a Fairey III.F and a Hawker-Horsley stationed with the Club.

## THE DANUM AERO CLUB

A flying club has been formed at Doncaster under the title of the Danum Aero Club. A temporary site for the aerodrome has been acquired at the old war-time aerodrome in Armthorpe Lane, and two Blackburn "Bluebirds" have been purchased.

There are about 50 members, and the promoters are Messrs. F. A. G. Alderson, Thorne Road; C. Lister, Priory Place, and H. Addy, of High Road, Balby.

The Club is to have the use of the Doncaster Municipal Aerodrome on the Low Pasture when this is ready. In connection with this aerodrome the Corporation is advertising for tenders for the preliminary work of excavation and levelling. The site is almost adjacent to the Racecourse.

The Danum Aero Club hope to commence their club flying before Easter. They will hold their inaugural dinner on March 10 at the Danum Hotel, Doncaster.

## HUSBANDS BOSWORTH MEETING

On Whit-Sunday, May 15, C. F. Lees will be holding a Flying Meeting at Cote Hill Aerodrome, Husbands Bosworth, Rugby, to which all owners of aircraft are cordially invited. Lunch will be provided and every effort made to give them an enjoyable afternoon. Further details will be published later.

## BRISTOL AND WESSEX

During 1931 the Bristol and Wessex Aeroplane Club machines flew 1,538 hr., with a gain of 24 new "A" licences, as compared with 1,591 hr. and 25 "A" licences for 1930. In view of the pessimistic attitude of the majority of people in the country, these figures must certainly be taken as very satisfactory. Some 8 members have already shown their interest in the blind flying course and are taking instruction. One of the club's Cirrus Moths has now been replaced by a Gipsy I Moth.

The Aviation Ball is being organised to take place at the Spar Hotel, Clifton, on March 11, when it is hoped that the Director of Civil Aviation will be present. This will be the last club dance of the winter season, and there is little doubt that members will appreciate the arrangements made for their entertainment as much as they have done on previous occasions.

The Airport Manager has been receiving the attention of burglars lately, and on one occasion they took away all his flying clothing. On the second occasion of their visit the police arrived opportunely, and the house-breakers were taken into custody; whether or not they took the clothing with them we are not told, nor is it disclosed how much of his clothing the Airport Manager calls *flying* clothing! Besides the meeting on June 4 the club will hold their Garden Party, this year, on October 1.

## CINQUE PORTS FLYING CLUB

Gusty weather has been against flying at Lympne during the past week, but in spite of this fact the number


**THE D.H. T.S. "MOTH": Students of the de Havilland Technical School and the "Gipsy Moth" which they have constructed at Stag Lane. We understand they intend to form a club and fly this machine at Hatfield.** (FLIGHT *Photo.*)

of hours on club aircraft shows an increase, so much so that two new members, Messrs. Bailey and Davis, are now rapidly nearing the stage when they are ready to go through their "A" licence tests.

Country membership is one of the latest privileges of the club, and this has been sanctioned by the Director of Civil Aviation. For an annual subscription of £1 1s., full privileges of the club will be allowed to those eligible. It is hoped that this will encourage pilots from other aerodromes to spend the week-end at Lympne.

## AT STAG LANE

The recent cold weather has improved the surface of the aerodrome considerably at Stag Lane, and there is now no longer such an abundance of mud. This has had the result that many more members of the London Aeroplane Club have been flying, and all the machines have been booked up for days past.

On Saturday, February 13, the club held one of its periodical dances, which, as usual, was a very cheery party. Over 70 members attended, and the club's own amateur orchestra provided the music in their customary excellent fashion.

March 5 will be something of a red-letter day, as it will be on that date that Mr. Gordon Store will receive an unofficial, but none the less hearty, welcome from the club members. Mr. Gordon Store, it will be remembered, was the pilot who so successfully lowered the record from England to Capetown when flying with Miss Peggy Salaman in her "Puss Moth" (Gipsy III).

Talks on semi-technical subjects are one of the attractions arranged by the club, and on February 20 Mr. A. Lawson gave a very interesting discourse on the "A.B.C. of Engine Lubrication." Full particulars of other lectures like this, which are to be given, will be sent on application to the Secretary.

The number of machines now run by the club is growing considerably, and among the newcomers is a three-seater Spartan (Hermes); besides this there are also owned by club members a Klemm (Pobjoy), a Redwing (Genet), and a "Moth" (Gipsy II), specially fitted for inverted flying.

## BROOKLANDS

Over 38 hr. instructional flying were carried out at the Brooklands School during the week; Mr. Rouse attaining his "A" licence, and Mrs. Joss, Lt. Shuttleworth, and Mr. A. Weyman going solo. Lady Chaytor and Mr. R. Richards are having their "Moth" fitted with extra tanks and a mass of gadgets in preparation for their flight to Australia, while Mr. C. W. A. Scott's "Moth" with Australian registration is also being prepared with navigation lights for another flight.

Mr. Ian Barr has been appointed Sales Manager to Brooklands Aviation Co., Ltd.; he also flies himself, in accordance with the policy of the company, whereby all the members of their staff are pilots.

Furniture is now being brought down to the new club-house, and this should be habitable very soon.

The first meeting of the Press Aero Club was held on Sunday, February 21, when some 20 members were shown all the accommodation at Brooklands, many of them taking their first flying lesson.

## INDIA'S FIRST AIR RACE

The air race for the Viceroy's Cup—previously referred to in these columns—was successfully flown on February 20. Modelled on our own King's Cup Air Race, this event, which was open to all Indian pilots and others holding an "A" licence trained at Indian or other flying clubs, was flown over a course of about 700 miles, from Delhi, via Agra, Jhansi, Lucknow, Agra, and back to Delhi.

Twelve competitors took part in the race, half being Indian and the other half English—including two women pilots, Mrs. A. F. Horsman and Miss Crossley (who took part in last year's King's Cup race). With the exception of Mr. B. D. Mookherji, of the Bengal Flying Club—who crashed his "Puss Moth" when landing at Lucknow—all competitors completed the course without accident. All the machines were British.

The Viceroy's Cup and Rs. 2,000 for the winner of the race on handicap was awarded to Dr. Sproul, of the Punjab Flying Club, on a "Gipsy I Moth," Mr. W. C. Wingfield, of the Bombay Flying Club, on a "Puss Moth," being second, and winning the Hari Kishen Das Challenge Shield and Rs. 1,000. The winner's speed was 96 m.p.h., and the speed of the second man was 126 m.p.h.

Mr. Wingfield also won the challenge trophy presented by Lord Wakefield for the fastest time, while a trophy for the most economical flight went to Mr. Gurbachan Singh, of the Delhi Club, on a "Gipsy I Moth." Mrs. Horsman, of the Cawnpore Club, won the cup for the first woman completing the course.

On the following day an Aerial Display was held at Delhi, in the presence of large crowds. The Viceroy, Lord Willingdon, accompanied by Lady Willingdon, attended on this occasion and presented the prizes.

## AT DUNSTABLE

All members of the instructional classes held during the week-end, February 13-14, by the London Gliding Club, were given quite a large number of flights each in either the "Zögling" or "Dagling." The total number of launches on Sunday was over 70. The clubhouse was successfully finished on the same day, and is now complete even down to the furnishing, fires, refreshments and newspapers.

The wind, which was from a north-westerly direction, was admirable at times for soaring, and those using the "Professor" had no difficulty in maintaining height; even the "Dagling" being kept in the air for 11 min. 56 sec., which is a record, as its pilot, Dewsbury, was only trying for a 45 sec. flight to get his "B" licence. That the conditions were excellent is emphasised by the fact that Messrs. Thomas, Dineen, and Collins made flights of over 50 sec. when gaining their "A" licences. Mr. Marcus Manton made a fine flight in the "Hols-der-Teufel," gaining more height than anyone else. Such expert pilots as Messrs. Petre, Williams, Smith, Culver and Scott-Hall were almost monotonous in their proficiency in the "Professor"; they simply rose to some 500 ft. above the hill and made flights up and down a beat of about two miles in length for just as long as they wished. A measure of the amount of soaring now being done by this club is the fact that frequently during the afternoon there were three machines in the air at once.

**The perpetual Trophy presented to the Portsmouth and Southsea Gliding Club by Capt. R. L. Yates.**

## PORTSMOUTH AND SOUTHSEA GLIDING CLUB

Portsdown Hill is an excellent soaring site, and the Portsmouth and Southsea Gliding Club recently issued an invitation for the members of other clubs to come and visit them. There is an added incentive now for them to do so, in the new trophy which has been presented by Capt. R. L. Yates, who is shortly leaving for Palestine. This trophy takes the form of a statuette of "Mercury," by Giovanni da Bologna, and is to be competed for from Portsdown Hill by any British pilot flying a British designed and built machine. The rules are being compiled by the B.G.A., but are not yet completely finished. It is understood that it will be flown for "distance," some time after April next.

## GLASGOW GLIDING CLUB.

Two gliders are being constructed in this Club's workshop by Mr. Graham and Mr. Tom Crawford. Both machines are of the intermediate type, that of Mr. Crawford being designed from an existing type, while Mr. Graham's is of original design, with several novel features.

# The AIRCRAFT ENGINEER

FLIGHT ENGINEERING SECTION

Edited by C. M. POULSEN

February 26, 1932


CONTENTS



## THE MUTUAL INFLUENCE OF ENGINE AND AIRSCREW CHARACTERISTICS


* By Lt.-Col. J. D. Blyth, O.B.E., A.F.R.Ae.S., M.I.Ae.E.


The improvements effected in the course of development of modern engines and aeroplanes make it a matter of increasing difficulty to design an airscrew which will absorb and use to the fullest extent, under all operational conditions, the power given out by the engine; especially in cases where the highest possible top speed in level flight combined with the greatest possible rate of climb are essential.

An engine has two speeds of primary importance: first, its normal r.p.m., *i.e.*, the maximum speed which may be maintained indefinitely at full throttle; and secondly, its maximum permissible r.p.m. which may be maintained for a limited period only. The maximum r.p.m. vary from 10 to 20 per cent. above normal r.p.m. in different engines.

To obtain the optimum performance of a machine it is obvious that the engine should be working, as nearly as possible, at its maximum permissible r.p.m. at top speed and its normal r.p.m. on climb.

The increase in horsepower of modern engines is obtained in various ways: by greater volume, higher r.p.m., supercharging, etc.; but whatever means are used to obtain the increase, the effect is the same, namely, that the slope of the curve of b.h.p. against airscrew r.p.m. becomes steeper, since the maximum rotational speed of the airscrew is limited by practical considerations of tip speed

We can say then, that $d(\text{B.H.P.})/d\text{N}$ increases as the power of an engine increases. The effect of this on the airscrew will be shown first from general principles, and a more detailed examination will be made later.

On page 321 of Bairstow's "Applied Aerodynamics," curves are shown of $K_QQ_c$ against $V/nP$. Here $K_Q$ is the torque coefficient; $Q_c$ is the reciprocal of $K_Q$ at $V/nP = 0.5$; V is the speed of advance in ft./sec.; $n$ the airscrew speed in revs./sec.; and P the experimental mean pitch, or advance per revolution at zero thrust.

The general equation of these curves is

$$K_QQ_c = 1 + \left(0{\cdot}017 + 0{\cdot}0738\frac{P}{D}\right)\left[1 - 8\left(\frac{V}{nP}\right)^3\right] \dots \text{(i)}$$

D being the diameter of the airscrew in feet.

For any particular airscrew the curve of $K_Q$ plotted against $V/nP$ is invariable, and therefore $Q_c$ is constant, as also are P and D; while

$$K_Q = \frac{550\ \text{B.H.P.}}{0{\cdot}00237\rho n^3 D^5} \times \frac{1}{2\pi} \quad \dots\dots\dots\dots \text{(ii)}$$

where $\rho$ is the relative density of the air at the height under consideration.

Equation (i) can be written, therefore, in the form $\frac{\text{B.H.P.}}{n^3} = a - b\left(\frac{V}{n}\right)^3$ (where $a$ and $b$ are constants), which becomes

$$\text{B.H.P.} \times an^3 - bV^3.$$

Differentiating

$$\frac{d(\text{B.H.P.})}{dn} = 3an^2 - 3bV^2\frac{dV}{dn} \quad \dots\dots\dots \text{(iii)}$$

Equation (iii) shows that for a given airscrew the rate of variation of r.p.m. with forward speed will depend upon the slope of the curve of b.h.p. against airscrew r.p.m.; and the steeper the slope the greater will be the variation of r.p.m. with forward speed.

In practice this means that if the slope of the power curve is too great an airscrew designed to give maximum r.p.m. at top speed will not allow the engine to reach normal r.p.m. on climb, and consequently brake horsepower will be lost by "holding down"; while if the slope is not great enough the r.p.m. on climb will exceed normal and the engine will have to be throttled, thus again losing power With modern engines the former effect is most probable unless the difference between normal and maximum r.p.m. is greater than 10 per cent.

The combination of increased horsepower and modern aeroplane design lead to high maximum speeds. Since the r.p.m. and diameter of the airscrew are limited,

* Col. Blyth is on the Technical Staff of the Gloster Aircraft Co., Ltd.

it follows that the value of $V/nD$ at top speed is high, and the airscrew requires a large value of the experimental mean pitch. This in its turn causes the r.p.m. to vary more rapidly with speed than is the case with a lower pitch, and the holding down effect of the airscrew on the engine becomes more pronounced. To examine this effect more closely it is necessary to know the value of $P/D$ for any airscrew under consideration.

To obtain the greatest possible thrust horsepower at any speed the airscrew must work at maximum efficiency at that speed.

The diameter of the airscrew is found from a knowledge of the speed and r.p.m. at which maximum efficiency is required; generally the maximum speed of the machine and maximum permissible r.p.m. of the engine are the governing factors.

A useful formula, given by Diehl in N.A.C.A. Report No. 178, is

$$D^4 = \left(\frac{90{,}000}{N}\right)^2 \cdot \frac{\text{B.H.P.}}{\rho V} \quad \ldots\ldots\ldots\ldots \text{(iv)}$$

Here $N$ = airscrew r.p.m. and $V$ = speed in m.p.h.

As we are examining airscrew characteristics whose curves are given in terms of ft./sec. and revs./sec., it will be more convenient to express the formula used in these units.

Equation (iv) now becomes:—

$$D^4 = \frac{33 \times 10^5}{n^2} \cdot \frac{\text{B.H.P.}}{\rho V} \quad \ldots\ldots\ldots\ldots \text{(v)}$$

$n$ and $V$ now being revs./sec. and ft./sec. respectively, and $\rho$ being, as usual, the relative density of the air.

Having found $D$ and knowing $V$ and $n$, the value of $V/nD$ can be calculated. We have now to find what value of $P/D$ will give maximum efficiency at this value of $V/nD$.

The thrust function curve given on page 321 of Bairstow's "Applied Aerodynamics" (and elsewhere) has for its equation

$$K_T T_c = \frac{4}{3}\left[1 - \left(\frac{V}{nP}\right)^2\right] \quad \ldots\ldots\ldots\ldots \text{(vi)}$$

Here $T_c$ is the reciprocal of $K_T$ at $V/nP = 0.5$, and is therefore constant.

The airscrew efficiency is given by the equation

$$\eta = \frac{1}{2\pi} \cdot \frac{P}{D} \cdot \frac{K_T T_c}{K_Q Q_c} \cdot \frac{V}{nP} \quad \ldots\ldots\ldots\ldots \text{(vii)}$$

Since at maximum efficiency $V/nD$ is fixed, and $= V/nP \times P/D$, the value of $\eta$ for any particular value of $P/D$ is greatest when $K_T T_c / K_Q Q_c$ is greatest.

From equations (i) and (vi)

$$\frac{K_T T_c}{K_Q Q_c} = \frac{\frac{4}{3}\left[1 - \left(\frac{V}{nP}\right)^2\right]}{1 + \left(0{\cdot}017 + 0{\cdot}0738\,\frac{P}{D}\right)\left[1 - 8\left(\frac{V}{nP}\right)^3\right]} \quad \text{(viii)}$$

Differentiating and simplifying we find that $\frac{K_T T_c}{K_Q Q_c}$ is maximum when

$$\left(1{\cdot}017 + 0{\cdot}0738\,\frac{P}{D}\right)\left[1 - 3\left(\frac{V}{nP}\right)^2\right] + 16\left(\frac{V}{nP}\right)^3\left(0{\cdot}017 + 0{\cdot}0738\,\frac{P}{D}\right) = 0$$

Re-writing this in terms of $P/D$ and $V/nD$ we get

$$\frac{P}{D} = \frac{\frac{P}{D}\left[3\left(\frac{V}{nD}\right)^2 - \left(\frac{P}{D}\right)^2\right]}{0{\cdot}0738\left[\left(\frac{P}{D}\right)^3 - 3\,\frac{P}{D}\left(\frac{V}{nD}\right)^2 + 16\left(\frac{V}{nD}\right)^3\right]} - 0{\cdot}2303 \quad \text{(ix)}$$

If the values of $P/D$ as given by this equation are plotted against $V/nD$ the curve obtained is in good agreement with results found in tests up to a value of $P/D$ of about 1.4 only. From R. & M. 829, which gives results of tests on a family of airscrews, values of $P/D$ against $V/nD$ at maximum efficiency can be obtained up to a value of $P/D$ of about 1.8. To fit these values equation (ix) has to be modified, and very fair agreement can be obtained by combining it with the equation

$$\frac{P}{D} = 1{\cdot}18\,\frac{V}{nD} + 0{\cdot}14.$$

The final equation for $P/D$ and $V/nD$ now becomes

$$\frac{P}{D} = \frac{\frac{P}{D}\left[3\left(\frac{V}{nD}\right)^2 - \left(\frac{P}{D}\right)^2\right]}{0{\cdot}1476\left[\left(\frac{P}{D}\right)^3 - 3\left(\frac{P}{D}\right)\left(\frac{V}{nD}\right)^2 + 16\left(\frac{V}{nD}\right)^3\right]} + 0{\cdot}59\,\frac{V}{nD} - 0{\cdot}045 \quad \text{(x)}$$

This curve is plotted in Fig. 1, and gives good agreement with test results up to the maximum value of $P/D$ tested. For values of $P/D$ greater than 1.9 it cannot be relied on; almost certainly a further modification to the equation would be required, but without tests at

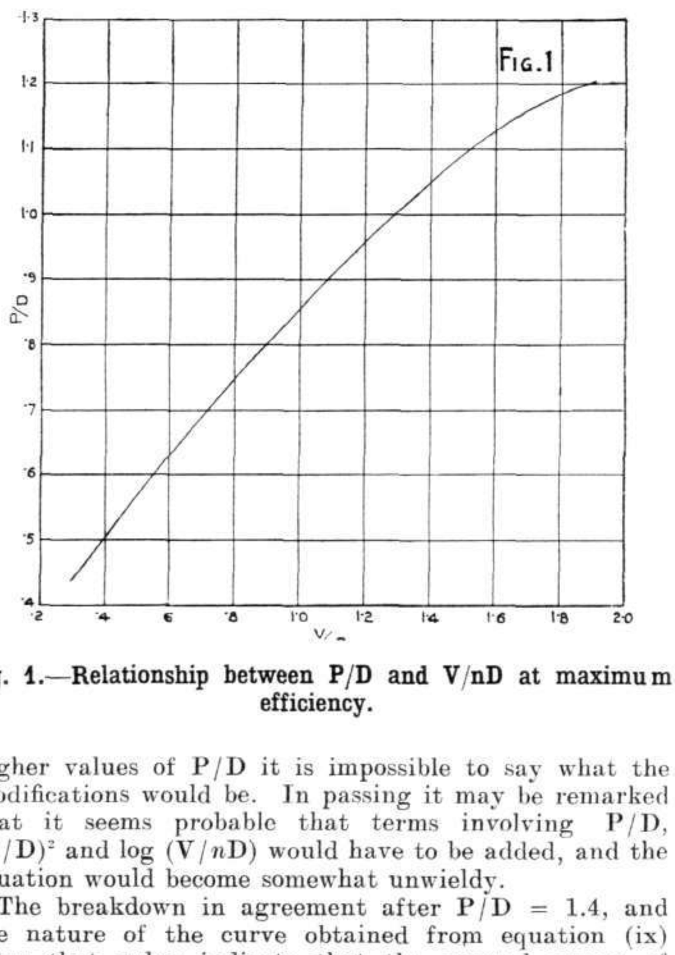



**Fig. 1.—Relationship between P/D and V/nD at maximum efficiency.**

higher values of $P/D$ it is impossible to say what the modifications would be. In passing it may be remarked that it seems probable that terms involving $P/D$, $(P/D)^2$ and $\log (V/nD)$ would have to be added, and the equation would become somewhat unwieldy.

The breakdown in agreement after $P/D = 1.4$, and the nature of the curve obtained from equation (ix) after that value indicate that the general curves of $K_Q Q_c$ against $P/D$ as given by equation (i) are applicable only for values of $P/D$ of less than 1.4. We will take, therefore, the curves of $K_Q$ against $V/nD$ from R. & M. 829, using those for two-bladed airscrews whose maximum blade width is 0.082D.

Returning to equations (ii) and (v) for $K_Q$ and $D$ we have

$$K_Q = \frac{550\ \text{B.H.P.}}{0{\cdot}00237\rho n^3 D^5} \cdot \frac{1}{2\pi} \quad \ldots\ldots\ldots\ldots \text{(ii)}$$

and

$$D^4 = \frac{33 \times 10^5}{n^2} \cdot \frac{\text{B.H.P.}}{\rho V} \quad \ldots\ldots\ldots\ldots \text{(v)}$$

In equation (ii) the value of b.h.p. is that which the airscrew will absorb, while in equation (v) the value of b.h.p. is that which the airscrew is required to absorb, *i.e.*, that of the engine. It is obvious that the two

values of b.h.p. must be equal. Eliminating the term b.h.p. from the two equations we find that for the airscrew to fulfil the design conditions it must satisfy the equation

$$K_Q = 0 \cdot 01118 \frac{V}{nD} \quad \text{(xi)}$$

Unless equation (xi) holds good the b.h.p. absorbed by the airscrew at the design r.p.m. will not be the same as that developed by the engine at the same speed, and the result will be that the r.p.m. obtained will not be those for which the airscrew is designed.

Fig. 2 gives curves of $K_Q$ against $V/nD$ for various values of $P/D$. These curves have been obtained by interpolation in the values given in R. & M. 829, and have been corrected to fulfil the conditions laid down in equation (xi).

It seldom occurs in practice that the exact value of the diameter obtained from equation (v) can be worked to. Not only does the fact that airscrew diameters are usually made in multiples of 3 in. lead to minor departures from the value, but considerations of tip clearance, etc., will frequently cause a considerable variation of the diameter from the ideal. When this occurs the value of $K_Q$ has to be brought to the necessary amount by varying the blade width. The curves in

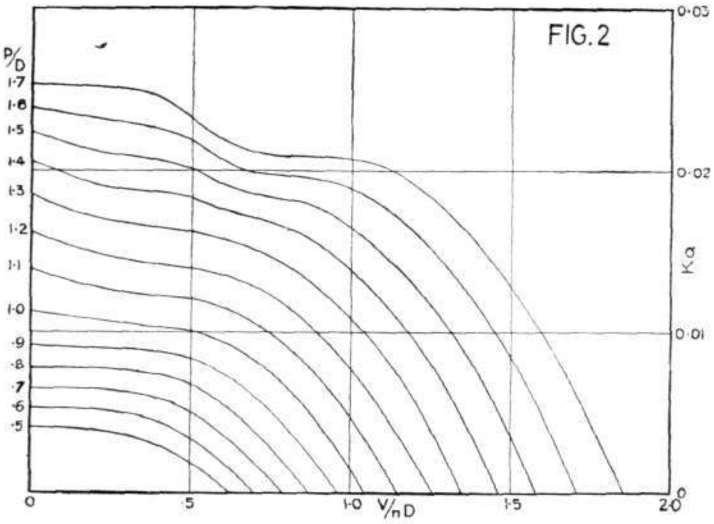



**Fig. 2.—Torque coefficients for standard airscrews.**

Fig. 2 are for a maximum blade width of 0.082D: for any other ratio of blade width to diameter the curve of $K_Q$ can be made to apply by multiplying its ordinates by the factor $f_Q$ which can be obtained from the curve in Fig. 3.

We are now in a position to determine the diameter and pitch of an airscrew to meet with requirements of r.p.m., b.h.p. and maximum speed; but not to ensure that it will also comply with the requirement of normal r.p.m. on climb.

The forward speed at which the rate of climb is a maximum will depend upon the characteristics of the whole machine; but on examination of a number of cases it will be found that the ratio of the climbing speed to the top speed is very nearly constant, the average value being approximately 0.65. Adopting this figure, and using the suffices Cl and M to denote climbing and maximum speed conditions, we have

$$V_{cl} = 0 \cdot 65\, V_M$$

If the r.p.m. on climb are normal we get, in the case of 10 per cent. over-revving being permitted,

$$n_{cl} = \frac{10}{11} n_M$$

and

$$\left(\frac{V}{nD}\right)_{cl} = 0 \cdot 715 \left(\frac{V}{nD}\right)_M \quad \text{(xii)}$$

When 20 per cent. over-revving is permitted, the relationship becomes

$$\left(\frac{V}{nD}\right)_{cl} = 0 \cdot 78 \left(\frac{V}{nD}\right)_M \quad \text{(xiii)}$$

Again, referring to equation (ii) we get

$$\frac{K_{Q_{cl}}}{K_{Q_M}} = \frac{B.H.P._{cl}}{B.H.P._M}\left(\frac{n_M}{n_{cl}}\right)^3 \quad \text{(xiv)}$$

In the case of 10 per cent. over-revving this gives

$$\frac{K_{Q_{cl}}}{K_{Q_M}} = 1 \cdot 331 \frac{B.H.P._{cl}}{B.H.P._M}$$

and in the case of 20 per cent. over-revving

$$\frac{K_{Q_{cl}}}{K_{Q_M}} = 1 \cdot 728 \frac{B.H.P._{cl}}{B.H.P._M}.$$

Since $B.H.P._{cl}$ is the b.h.p. of the engine at normal r.p.m., the ratio $B.H.P._{cl}/B.H.P._M$ can be obtained from the power curve of the engine; and unless the value so found gives the same value of $K_{Q_{cl}}/K_{Q_M}$ as is given by the curve of $K_Q$ against $V/nD$ for the par-

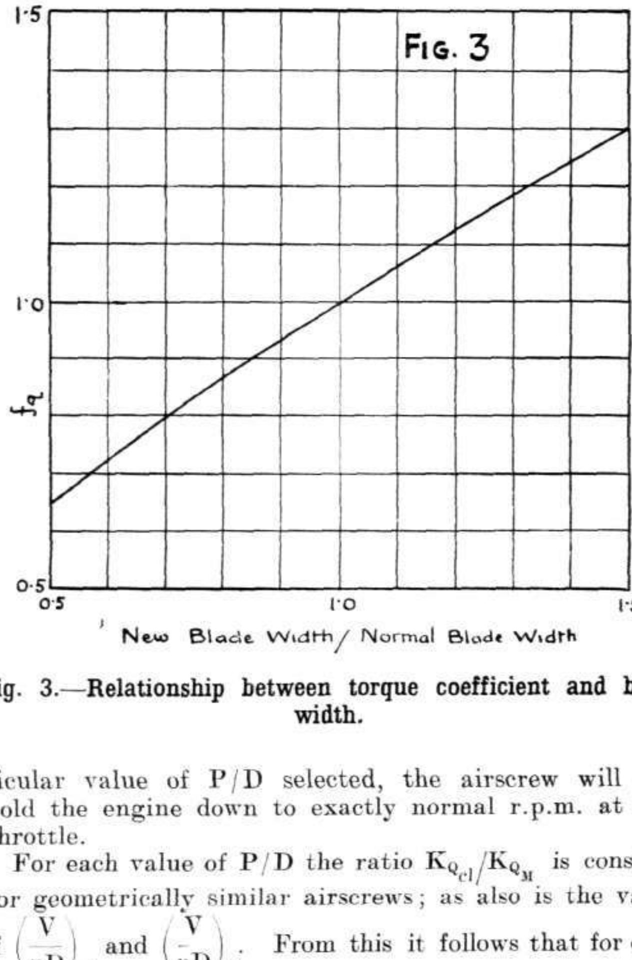



**Fig. 3.—Relationship between torque coefficient and blade width.**

ticular value of $P/D$ selected, the airscrew will not hold the engine down to exactly normal r.p.m. at full throttle.

For each value of $P/D$ the ratio $K_{Q_{cl}}/K_{Q_M}$ is constant for geometrically similar airscrews; as also is the value of $\left(\frac{V}{nD}\right)_{cl}$ and $\left(\frac{V}{nD}\right)_M$. From this it follows that for each value of $P/D$ there is only one ratio of $B.H.P._{cl}/B.H.P._M$ which will give maximum r.p.m. at maximum efficiency at top speed, and also normal r.p.m. on climb.

Since D is fixed by $B.H.P._M$, V, and $n$, P is also fixed, and in consequence it appears that unless $n$ can be varied any particular engine will fulfil the required conditions only for a given and invariable value of V. For any other value of V the conditions of maximum and normal r.p.m. at top speed and climb respectively can be attained by adjusting the value of $P/D$ and the blade area; but the alteration of $P/D$ will affect the combination of speed and r.p.m. at which the point of maximum efficiency occurs.

The curves in Fig. 4 have been drawn from Figs. 1 and 2, and show for any value of $B.H.P._{cl}/B.H.P._M$ the

value of $V/nD$ at maximum speed which will require a value of $P/D$ such that the required conditions will be fulfilled. It will be seen from the figure that, in the case of 10 per cent. over-revving only being permitted at top speed the value of $(V/nD)_M$ will not reach 0.9 unless $B.H.P._{cl} = B.H.P._M$, an improbable and undesirable condition.

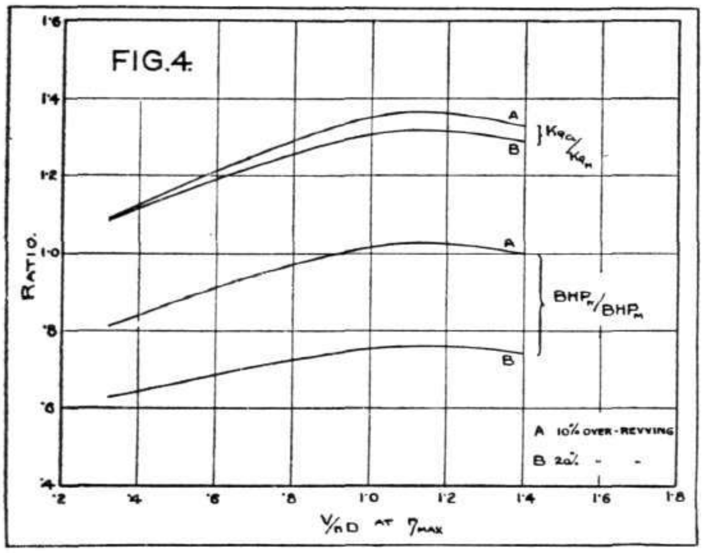



**Fig. 4.—Engine and airscrew characteristic ratios to give maximum r.p.m. at top speed and normal r.p.m. on climb.**

The value of $n$ can be altered by introducing gearing so that the airscrew r.p.m. are not the same as the engine r.p.m.

From equation (v)

$$D^4 = \frac{33 \times 10^5}{n^2} \cdot \frac{B.H.P._M}{\rho V}$$

we get

$$n = \frac{V^2}{100\left(\dfrac{V}{nD}\right)^2_M} \sqrt{\frac{\rho V}{330\,B.H.P._M}} \quad \ldots\ldots \text{(xv)}$$

The value of $(V/nD)_M$ is found from Fig. 4 for the value of $B.H.P._{cl}/B.H.P._M$ given by the power curve of the engine selected, and substituted in equation (xv). The equation is solved for $n$, the value of $n$ so found giving the necessary revs./sec. of the airscrew. The necessary gear ratio is found by dividing this value of $n$ by the engine revs./sec.

*(To be continued)*

## CLIMB RELATIONSHIPS

By W. R. ANDREWS, A.F.R.Ae.S.

*(Concluded from page 4)*

### "Absolute Ceiling."

The next relationship to be investigated is the "absolute ceiling." To satisfy our imposed conditions of usefulness this must be expressed in terms of the ground level rate of climb.

The generalised curves for absolute ceiling (Ref. 2) in terms of the ratio of b.h.p. required to b.h.p. available at the point of minimum power required are of little use for our purpose.

These curves give a ready means of ascertaining the absolute ceiling when an estimate has been made of the t.h.p. required and available at ground level over the entire speed range. They do not help in the estimation of absolute ceiling from the known performance at another gross weight.

The writer has found that for any particular aircraft the absolute ceiling can be expressed as

$$H = K_5\, R^{\frac{2}{3}} \quad \ldots\ldots\ldots\ldots \text{(6)}$$

$H$ = Absolute ceiling feet.

$R$ = Initial rate of climb f.p.m.

$K_5$ = Constant for any aircraft.

The performance of our hypothetical aircraft has been worked out for an altitude of 15,000 ft.

In performance estimating, it is found that the rate of climb curve with height is a slight curve. For the purpose of this article, it is assumed to be a straight line. This will tend to under-estimate the absolute ceilings of the fastest climbing aircraft, that is, at a gross weight of 5,000 lb.

The initial rate of climb, and absolute ceiling, in this case, are greater than those usually encountered in civil aircraft,* being 1,830 f.p.m. and 24,650 ft. respectively.

The rates of climb under the various conditions are given by Fig. 8. It will be noticed that for any particular aspect ratio there is a systematic drop in absolute ceiling with increase in weight. There is also an equally regular increase in absolute ceiling at constant weight with increasing aspect ratio.

Perhaps this will be made clearer by Table VI where the results are collected according to weight and aspect ratio.

TABLE VI.

| A | W lbs. | Initial Rate of Climb. R. f.p.m. | Rate of Climb at 15,000 ft. f.p.m. | Absolute Ceiling. H. feet. | $R^{\frac{2}{3}}$ | $\frac{H}{R^{\frac{2}{3}}} = K$ |
|---|---|---|---|---|---|---|
| 6 | 5,000 | 1,830 | 706 | 24,650 | 150·0 | 165 |
| 6 | 7,000 | 1,170 | 278 | 19,650 | 111·1 | 177 |
| 6 | 9,000 | 759 | − 11 | 14,800 | 83·3 | 178 |
| 3 | 7,000 | 929 | − 68 | 14,000 | 95·2 | 147 |
| 9 | 7,000 | 1,250 | 400 | 22,050 | 116·1 | 190 |

The absolute ceiling for the gross weight of 5,000 lb. is approximately 10,000 ft. above the point where the highest rate of climb was ascertained (15,000 ft.).

An estimate of the rate of climb for 5,000 lb. gross weight and an aspect ratio of 6 at a height of 25,000 ft. gave a rate of climb of 150 ft./min., so that the ceiling for this case is much in excess of that given by the straight line through the rates of climb at 15,000 ft. and at ground level. Had the height of 25,000 ft. been used in place of 15,000 ft. for the second height, the estimated absolute ceiling would have been 27,000 ft.

From this the value of $K_5$ would have been

$$165 \times \frac{27{,}000}{24{,}650} = 181,$$ which is in close agreement with the values of 177 for 7,000 lb. and 178 for 9,000 lb. gross weight.

Small corrections to the absolute ceilings at the other weights might be applied due to the same cause. As these are fairly near to 15,000 ft. the correction would not be sufficiently large to affect the results materially.

The slower the initial rate of climb the less curved is the estimated rate of climb curve with altitude.

It is essential with fast-climbing aircraft to choose one point as near as possible to the absolute ceiling, if a reliable estimate is to be made.

* The result, therefore, is not of paramount importance, but is included for completeness.

It was not worth the labour involved to estimate accurately the rate of climb at various heights to obtain the true shape of this one curve.

This question is taken up later in discussing the results of this series of the investigations.

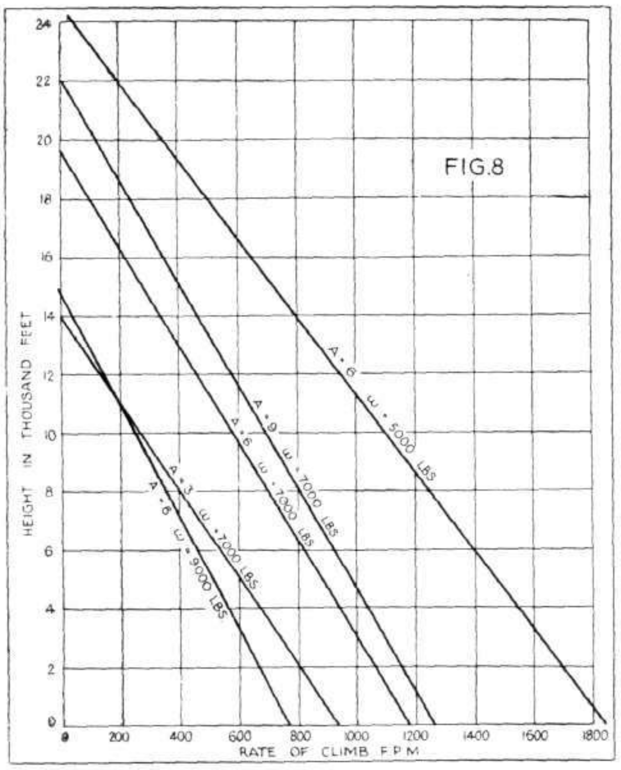



**Fig. 8.—Rates of Climb at any Height**

The variation of $K_5$ with aspect ratio is given in Fig. 9, from which is found

$$K_5 = 210 - \frac{186}{A} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (7)$$

In practice, the value of $K_5$ for an aircraft fitted with altitude control will be more nearly $235 - \frac{186}{A}$.

As in the case of the formula for the rate of climb, the results obtained will be slightly modified by the value of the parasite drag coefficient. The most that can be expected of any formula is to give mean results when applied to aircraft for which test data is not available.

As mentioned previously (Ref. 2) a method of estimating the absolute ceiling in terms of the t.h.p. available and required at ground level is due to Lt. Diehl. This is based on the minimum t.h.p. for level flight.

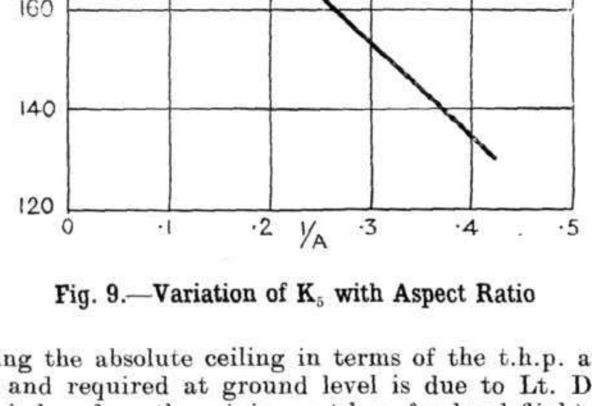



**Fig. 9.—Variation of $K_5$ with Aspect Ratio**

A similar relationship holds for the t.h.p. at the best climbing speed, as shown by Fig. 10. The data used are supplied by Figs. 3, 4 and 8. The higher ceiling for 5,000 lb. aspect ratio 6 due to estimating at 25,000 ft. instead of 15,000 ft. has not been used as it is obviously not uniform with the remainder.

This curve, while having no bearing on the formulæ already deduced, shows that such a curve can be found which will agree with full-scale tests for any aspect ratio. Under these conditions, it would then only be necessary to estimate the ground level performance, the ceiling being read off the curve.

This completes the investigation as far as the evolution for formulæ is concerned.

It is now proposed to work two examples to show more clearly the application of the methods. The first case chosen is that where previous tests, at a different weight, have been carried out. The second case is an estimate where nothing is known regarding the performance of the aircraft, except top speed and the stalling speed.

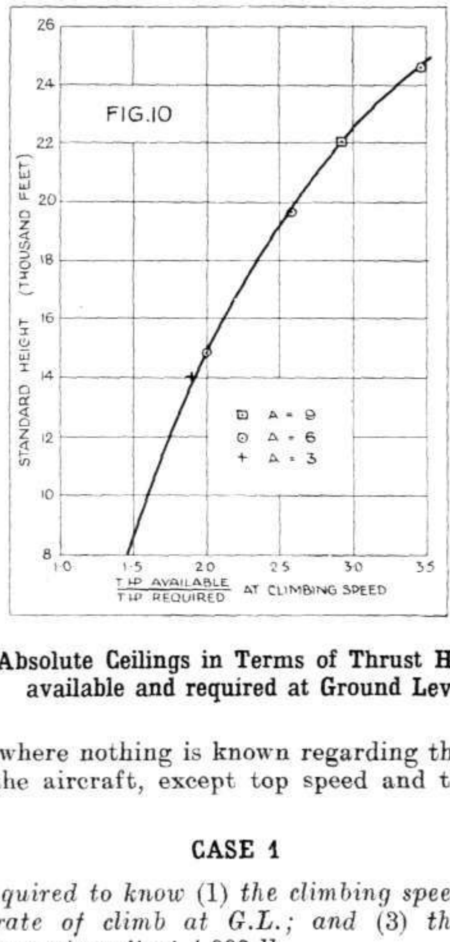



**Fig. 10.—Absolute Ceilings in Terms of Thrust Horse Power available and required at Ground Level**

### CASE 1

*It is required to know (1) the climbing speed at G.L.; (2) the rate of climb at G.L.; and (3) the absolute ceiling of an aircraft at 4,000 lb.*

The aircraft has the following dimensions:—

| | |
|---|---|
| Span (top and bottom) ... ... | 35 ft. |
| Chord (top and bottom) ... ... | 5 ft. |
| Gap at C.S. ... ... ... ... | 5.5 ft. |

**Measured Performance at 3,000 lb. gross weight**

On test at 3,000 lb. the following fully corrected results were obtained:—

| | |
|---|---|
| Maximum speed at G.L. ... ... | 120 m.p.h. |
| Maximum rate of climb ... ... | 1,000 f.p.m. |
| Best climbing speed at G.L. ... | 78 m.p.h. |
| Absolute ceiling ... ... ... | 19,200 ft. |
| Stalling speed at G.L. ... ... | 53 m.p.h. |

**The Estimation of the Equivalent Monoplane Aspect Ratio**

This is carried out as previously described in FLIGHT (Ref. 3).

A rough approximation to the aspect ratio of a biplane where the top and bottom wings are of equal span and chord is

$$A = 0.536 \frac{\text{Span}}{\text{Chord}} + 0.65 \frac{\text{Gap}}{\text{Chord}} \quad \ldots\ldots\ldots \quad (8)$$

$= 4.47$ in this particular case.

### ESTIMATION OF STALLING SPEED

The stalling speed at 4,000 lb. is given by

$$V_s\ (4{,}000\text{ lb.}) = V_s\ (3{,}000\text{ lb.}) \times \sqrt{\frac{4{,}000}{3{,}000}}$$
$$= 53\sqrt{\frac{4{,}000}{3{,}000}}$$
$$= \underline{61\text{ m.p.h.}}$$

### ESTIMATION OF CLIMBING SPEED

This is obtained indirectly by means of equation (4) which rewritten gives

$$V_c\ (\text{initial}) = V_s + \frac{V_m - V_s}{K_4} \qquad (9)$$

$$\text{therefore } K_4 = \frac{V_m - V_s}{V_c - V_s}$$

which on substitution gives

$$K_4 = \frac{120 - 53}{78 - 53} = \frac{67}{25} = \underline{2.68}.$$

Therefore at 4,000 lb. (assuming the top speed unchanged) the climbing speed will be given by

$$V_c = 61 + \frac{120 - 61}{2.68}\text{ m.p.h.}$$
$$= 61 + \frac{59}{2.68}$$
$$= 61 + 22$$
$$= \underline{83\text{ m.p.h.}}\text{ at 4,000 lb.}$$

### ESTIMATION OF INITIAL RATE OF CLIMB

It will be noticed that no mention is made of the b.h.p. of the engine, nor is this item necessary.

As explained previously the value of $K_2 \times \eta \times$ b.h.p. in (1) is evaluated from the known performance and need not be separated. The numerical value is then used in estimating the rate of climb for another weight.

$$\text{Rearranging 1 gives } K_2\cdot\eta\cdot\text{b.h.p.} = \left(\frac{R}{K_1} + V_s\right) \ldots\ldots \quad (10)$$

The value of $K_1$ is given by equation (3) thus

$$K_1 = 1.75 + \frac{28.7}{A}$$
$$= 1.75 + \frac{28.7}{4.47}$$
$$= 1.75 + 6.41$$
$$= \underline{8.16}.$$

Inserting this value for $K_1$ in (10) gives

$$K_2\cdot\eta\cdot\text{b.h.p.} = 3{,}000\left(\frac{1{,}000}{8.16} + 53\right)$$
$$= 3{,}000\ (122.5 + 53)$$
$$= \underline{526{,}500}.$$

Therefore the climb at 4,000 lb. will be given by resubstitution in equation (1) thus

$$R\ (4{,}000\text{ lb.}) = 8.16\left(\frac{526{,}500}{4{,}000} - 61\right)$$
$$= 8.16\ (131.6 - 61)$$
$$= 8.16 \times 70.6$$
$$= \underline{576\text{ f.p.m.}}\text{ Initial rate of climb.}$$

### ESTIMATION OF ABSOLUTE CEILING

The initial rate of climb at 3,000 lb. is 1,000 f.p.m. In equation (5) it is shown that the absolute ceiling is given by

$$H = K_5\, R^{\frac{2}{3}}$$

Therefore

$$K_5 = \frac{H}{R^{\frac{2}{3}}} \quad \ldots\ldots\ldots\ldots \quad (11)$$

$R = 1{,}000$. $\therefore R^{\frac{1}{3}} = 10$ and $R^{\frac{2}{3}} = 100$, therefore

$$K_5 = \frac{19{,}200}{100} = \underline{192}.$$

At 4,000 lb. then the absolute ceiling corresponding to an initial rate of climb of 500 f.p.m. will be

$$H = 192 \times 576^{\frac{2}{3}}$$

now $576^{\frac{1}{3}} = 8.32$ and $576^{\frac{2}{3}} = 69.3$ (by slide-rule)

$$\text{therefore } H = 192 \times 69.3 = \underline{13{,}300\text{ ft.}}$$

### SUMMARY, CASE 1

| | Known for Gross Weight of 3,000 lb. | Estimated for Gross Weight of 4,000 lb. |
|---|---|---|
| Top Speed ... ... ... | 120 m.p.h. | Assumed, 120 m.p.h. |
| Stalling Speed ... ... ... | 53 m.p.h. | 61 m.p.h. |
| Climbing Speed at G.L. ... | 78 m.p.h. | 83 m.p.h. |
| Rate of Climb at G.L. ... ... | 1,000 f.p.m. | 576 f.p.m. |
| Absolute Ceiling ... ... ... | 19,200 ft. | 13,300 ft. |

### CASE 2

*It is required to estimate—*

(a) *The best climbing speed at G.L.;*
(b) *The initial rate of climb;*
(c) *The absolute ceiling;*

*for an aircraft having the following particulars:—*

Span (top and bottom) ... ... 32 ft.
Chord (top and bottom) ... ... 5.0 ft.
Gap ... ... ... ... ... 5.5 ft.
Gross weight ... ... ... 2,500 lb.
Top speed ... ... ... ... 115 m.p.h.
Stalling speed (equiv. monopl.)... 52 m.p.h.
Engine ... ... ... ... Lynx IV.c.
Normal b.h.p. = 215 at 1,900 r.p.m.
Airscrew dia. = D = 7 ft. 9 in.
,, pitch = $P_f$ = 5.0 ft.

The equivalent monoplane aspect ratio of the wing system is given by substitution in (8) thus

$$A = 0.536 \times \frac{35}{5.0} + 0.65 \times \frac{5.5}{5.0}$$
$$= 3.68 + 0.72$$
$$= \underline{4.40}.$$

#### (a) Estimation of Climbing Speed

This, as in Case 1, is estimated by means of equation (4).

First obtain the value of $K_4$ by means of equation (5) thus:—

$$K_4 = 3.22 - \frac{2.44}{A}$$
$$= 3.22 - \frac{2.44}{4.4}$$
$$= 3.22 - 0.555$$
$$= \underline{2.665}$$

then substituting in (4) gives

$$V_c = 52 + \frac{115 - 52}{2.665}$$
$$= 52 + 23.6$$
$$= \underline{75.6\text{ m.p.h.}}$$

**(b) Estimation of Rate of Climb at Ground Level**

The equations necessary for this estimation are (1), (2) and (3).

$$(1)\ R = K_1 \left[\frac{K_2 \cdot \eta \cdot B.H.P}{W} - V_s\right]$$

$$(2)\ K_2 = 660 + 496\,A$$

$$(3)\ K_1 = 1.75 + \frac{28.7}{A}$$

by substituting appropriate values we get

$$K_2 = 660 + 2{,}280 = \underline{2{,}940}$$

$$\text{and } K_1 = 1.75 + 6.52 = \underline{8.27.}$$

The value of efficiency is given by Fig. 11 where the speed $V_1$ is the model test speed corresponding to a full-scale speed V (Ref. 5).

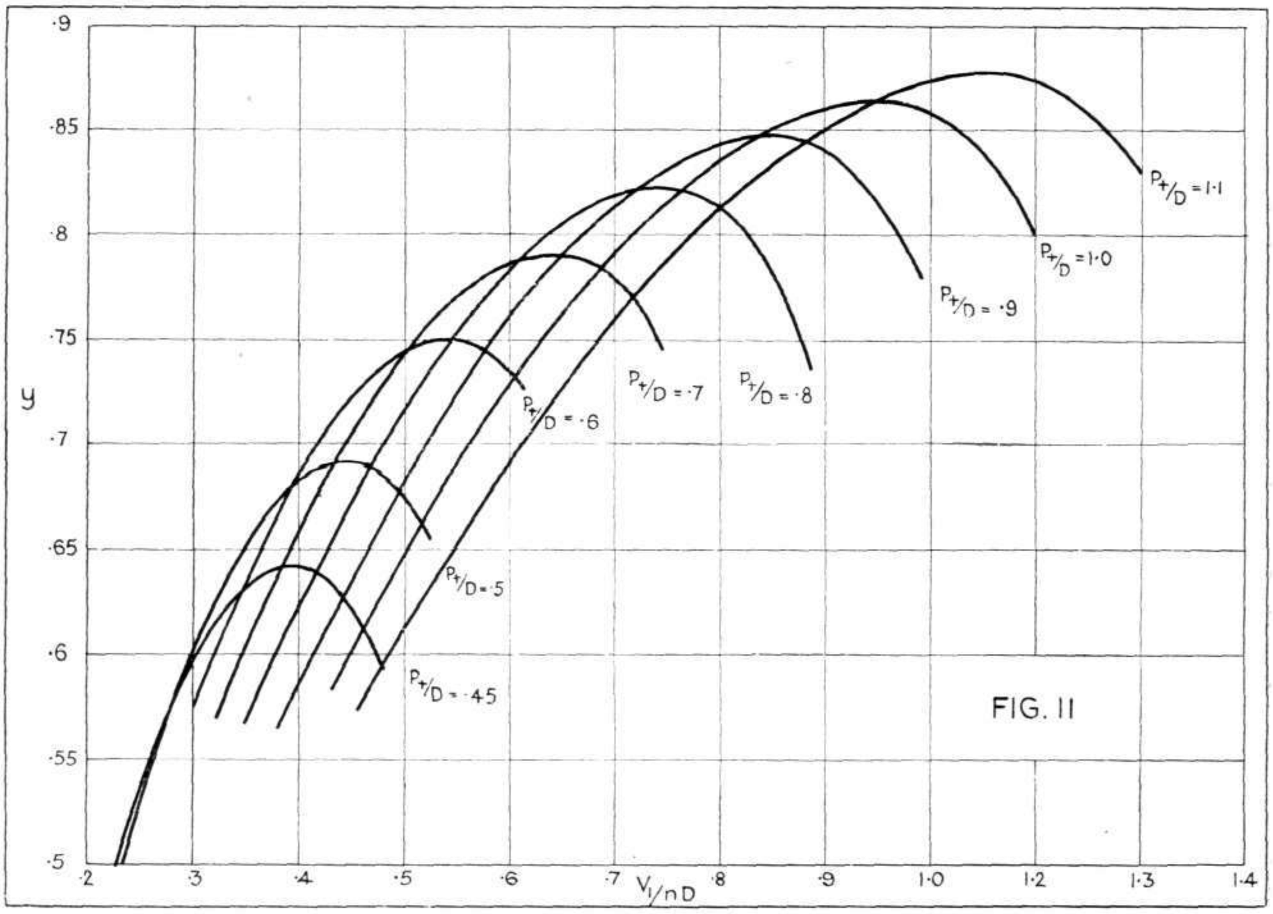



**Fig. 11.—Airscrew Efficiency**

The value of $\frac{V}{V_1}$ appears to vary from about 1.02 for water-cooled and four in line engines to 1.1 for radial engines and orthodox fuselage shapes.

Assume in this case that $\frac{V}{V_1} = 1.1$ then

$$\frac{V_1}{nD} = \frac{75.6 \times 88}{1{,}900 \times 7.75 \times 1.1} = \underline{0.41}$$

$$\text{and } \frac{P_t}{D} = \frac{5.0}{7.75} = \underline{0.645.}$$

Therefore from Fig. 11 the free air efficiency is 0.67.

The net efficiency in the case in question will be approximately 88 per cent. of this, *i.e.*, "$\eta$" = 0.88 × 0.67 = 0.59.

The figure of 88 per cent. is what is known as the slip factor (see Ref. 1), which allows for the increase in drag of parts affected by slipstream. The guess made here is purely an "experience" one based on estimates on similar aircraft.

Substituting these values in (1) gives

$$R = 8.27\left[\frac{2{,}940 \times 0.59 \times 215}{2{,}500} - 52\right]$$
$$= 8.27\,[149.5 - 52]$$
$$= 8.27 \times 97.5$$
$$= \underline{808 \text{ ft./min.}}$$

**(c) The Estimation of Absolute Ceiling**

The absolute ceiling is estimated by means of equations (6) and (7).

$$H = K_5 R^{\frac{2}{3}}$$

$$K_5 = 210 - \frac{A}{186} = 210 - 42.2 = \underline{167.8}$$

$$\therefore H = 167.8 \times 808^{\frac{2}{3}}$$

$$\text{now } 808^{\frac{1}{3}} = 9.315$$

$$\text{therefore } 808^{\frac{2}{3}} = 86.8$$

$$\text{and } H = 167.8 \times 86.8 = \underline{14{,}550 \text{ ft.}}$$

Actually on full-scale tests the absolute ceiling obtained with such an aircraft would probably be about 16,700 ft.

**SUMMARY, CASE 2**

| | |
|---|---|
| Climbing speed at G.L. ... ... | 75.6 m.p.h. |
| Rate of climb at G.L. ... ... | 808 f.p.m. |
| Absolute ceiling ... ... ... | 14,550 ft. to 16,700 ft. |

The estimation of the A.S.I. on climb is fairly easily estimated when the aircraft performance is known at some particular weight.

A guide is given by the fact that at the absolute ceiling the A.S.I. reading will be substantially the same for all weights and roughly corresponds to the A.S.I. for minimum t.h.p. required for level flight.

[2] "Engine Performance and the Determination of Absolute Ceiling." Diehl N.A.C.A. Report No. 171.
[3] "The Tail Plane Area to give Longitudinal Stability." Andrews, FLIGHT, June 27 and July 25, 1929.
[4] "Applied Aerodynamics." L. Bairstow.
[5] R. & M. 1254. A Method of Calculating Airscrew Characteristics. Capon.

# TECHNICAL LITERATURE

## SUMMARIES OF AERONAUTICAL RESEARCH COMMITTEE REPORTS

**These Reports are published by His Majesty's Stationery Office, London, and may be purchased directly from H.M. Stationery Office at the following addresses: Adastral House, Kingsway, W.C.2; 120, George Street, Edinburgh; York Street, Manchester; 1, St. Andrew's Crescent, Cardiff; 15, Donegall Square West, Belfast; or through any Bookseller.**

PRESSURE AND FORCE MEASUREMENTS ON AIRSCREW-BODY COMBINATIONS. By H. Bateman, B.Sc., D.I.C., and F. C. Johansen, M.Sc., A.M.I.Mech.E. R. & M. No. 1380 (Ae. 505). (62 pages and 16 diagrams.) December, 1930. Price 3s. net.

Airscrew body research has, in the past, been confined mainly to work on tractor airscrews and only one research on pusher screws, relating to an airscrew behind a very bluff body, is included in the R. & M. Series. The results of these experiments, described in R. & M. 830,* lead to the conclusion that the net efficiency of the pusher combination is at least of the same order as that of the tractor, despite an unsuitable shape of pusher body. It may reasonably be supposed, therefore, that pusher airscrews in combination with suitably designed bodies, may yield efficiencies in excess of those occurring with tractor screws, especially in view of the high velocities to which the body is subject in the tractor position as a result of its situation in the slipstream.

The present series of experiments has, therefore, been carried out with the object of making a detailed comparison between one tractor and two pusher airscrew combinations. For this purpose a short streamline body with rounded tail was chosen as being suitable for either a tractor or pusher body, and arrangements were made whereby a medium-pitched airscrew could be placed in the three positions to be tested. For each position a spinner was fitted to the airscrew so as to maintain unbroken the contour of the body.

The experiments extend the work on tractor airscrew-body combinations described in R. & M. 1230† and 1284.‡

The influence of the airscrew on the pressure distribution over the body is most marked in the neighbourhood of the screw, and generally more noticeable in the case of the forward pusher position, where the screw is appreciably distant from either extremity of the body, than in the tractor or after pusher positions. The variation of surface pressure with airscrew thrust follows an approximately linear relationship. With each combination tested, a region of high negative pressure was observed in the region of the tail at large airscrew thrusts, constituting a "spoiling effect," probably due to rotation of the slipstream. In combination with a low-resistance body, tractor and pusher screws with the same proportion of spinner shielded have equal overall maximum efficiency (64·8 per cent.). The forward pusher combination, with larger spinner, is least efficient. These may be contrasted with the maximum efficiency (72·0 per cent.) of the airscrew blades alone. With a high resistance body the pusher combinations are more efficient than the tractor (56·8 per cent.), and of the two pushers, that having the smaller spinner shielding is more efficient (61·6 per cent.). The presence of a rounded tail aft of the pusher screws has negligible effect on the net efficiency of the airscrew-body combination.

* R. & M. 830. Experiments with a family of airscrews, including effect of tractor and pusher bodies. Part II—Fage, Lock, Bateman and Williams.
R. & M. 1030. Experiments with a family of airscrews, including effect of tractor and pusher bodies. Part IV.—On the effect of placing the airscrew in various positions within the nose of a streamline body.—Bateman, Townend and Kirkup.
† R. & M. 1230. Pressure plotting a streamline body with tractor airscrew running—Lock and Johansen.
‡ R. & M. 1284. Pressure plotting a streamline body with tractor airscrew running. Part II. Airscrew in rear position.—Lock and Johansen.

EXPERIMENTS ON THE GROWTH OF CIRCULATION ABOUT A WING WITH A DESCRIPTION OF AN APPARATUS FOR MEASURING FLUID MOTION. By P. B. Walker, M.A., Ph.D. From work done in the Aeronautical Laboratory of the University of Cambridge directed by Prof. B. M. Jones, A.F.C., M.A., F.R.Ae.S., and W. S. Farren, M.B.E., M.A., F.R.Ae.S. R. & M. No. 1402 (Ae. 523). (75 pages and 44 diagrams.) January, 1931. Price 4s. 6d. net.

The apparatus consists of a water tank through which models are towed and the behaviour of the fluid photographed with the aid of oil particles in the water. It is intended for accurate quantitative investigation of the flow produced by wings and cylinders at a moderately high Reynolds number and appears to be the most suitable means of investigating such flow before the motion has reached a steady state. Experiments have been made with R.A.F. 30 wing section and the results compared with calculations made with the aid of a mathematical theory published by Wagner for the early unsteady flow about a wing.

Similar work which has been done previously has usually given results of a qualitative nature, and for a low Reynolds number Such is the work of R. & M. 1065, but in this case the apparatus used gave promise of being developed into an instrument of precise measurement, with the possibility of a greatly increased Reynolds number.

The author had the original water-tank in which the experiments of R. & M. 1065 were made, and Mr. W. S. Farren supplied to him complete designs for the mechanism which propels the model through the water. The early part of the first chapter gives a brief description of the driving machinery, and is followed by the developments and improvements which have been made during the course of my research. The remaining chapters of Part I describe the investigations which have been made, and the apparatus which has been constructed during the two years which were required to bring the new instrument reasonably near to perfection.

The apparatus in its present form may become a standard instrument for certain classes of work, which cannot be done in the wind tunnel. In particular, it appears to provide the most suitable means of investigating the flow round a wing (or cylinder), before the motion has reached a steady state.

When the apparatus had been proved consistent and reliable, and the technique of its operation thoroughly mastered, the work described in Part II was begun. A series of photographs of the flow round R.A.F.30 were taken at various distances from the starting position. The photographs reproduced here show the flow when the wing has travelled one chord, and intermediate distances up to six chords. These have been analysed with a measuring microscope designed for the purpose, with the object of extracting the most useful information for a given expenditure of time, and in particular the value of the circulation. Observations have been reduced to the form of curves, a large number of which have been reproduced here; the most important being the curve which gives circulation against length of run.

Recently Wagner published a mathematical theory for the early unsteady flow about a wing. This, if correct, is of great importance, since its applications to aerodynamical problems appear to be unlimited: but it has not hitherto received experimental confirmation. I have, therefore, applied Wagner's theory to the flow which is here investigated experimentally and made a comparison. The conclusion reached is that Wagner's theory can be used to predict the unsteady flow about a symmetrical wing, with a fair degree of accuracy.

THE EFFECT OF VARIOUS TYPES OF LATERAL STABILISERS ON THE TAKE-OFF OF A FLYING-BOAT. By L. P. Coombes, B.Sc., and R. H. Read, B.Sc. Communicated by the Director of Scientific Research, Air Ministry. R. & M. No. 1411 (Ae. 532). (5 pages and 6 diagrams.) October, 1930. Price 6d. net.

Large seaplanes are usually constructed with a single hull, and owing to the fact that with this type of construction the metacentre is below the centre of gravity of the aircraft, the hull alone is unstable laterally. Some means of securing lateral stability must, therefore, be employed, and three methods are commonly used. These are:—(a) hull with wing tip floats, (b) hull with inboard floats, (c) hull with stubs.

The question as to which of these arrangements is the best is to some extent a matter of opinion, and the view commonly held in this country is that though a hull fitted with stubs is the most satisfactory for seaworthiness, the loss of efficiency during take-off due to the extra resistance and weight introduced by the stubs is too great a price to be paid. The effect of the additional resistance due to any particular arrangement could be deduced from the results of systematic tank tests, provided these were available. Unfortunately, no systematic tests with various types of stabilisers have been done, and the resistance of any arrangement must be estimated from scattered tests on different hulls. In spite of this difficulty, it has been thought worth while to calculate the effect of different types of lateral stabilisers on the take-off of a flying boat, and for this purpose the Short "Singapore I" has been taken as typical.

The data on which the calculations were based were deduced partly from model results and partly from full scale tests. Calculations for the time to take-off over a range of weights was done. Further, the suitability of throttled take-off tests for predicting the limiting weight at which a seaplane can take-off was investigated.

The loss of efficiency due to fitting either inboard floats or stubs in lieu of wing tip floats is very great, amounting to a reduction in service load of 9 per cent. and 17 per cent. respectively for a take-off of 60 seconds in calm conditions.

Throttled take-offs at normal load, while they are convenient, may give rise to errors of the order of 2 per cent. if used for predicting the maximum weight at which a seaplane can be taken off in a reasonable time.

THE ADHESION AND FATIGUE OF THIN COATINGS OF WHITE METAL DEPOSITED ON MILD STEEL SURFACES. By T. E. Stanton. R. & M. No. 1424 (M. 74). (8 pages and 2 diagrams.) December, 1930. Price 6d. net.

The cracking of white metalled bearings under service conditions and the possibility of improving the fatigue strength of the white metal, has been investigated at the National Physical Laboratory to find the effect of composition and method of application on the adhesion and fatigue of such coatings.

Rings of S.14 mild steel 3 in. in external diameter, 1·5 in. long and 0·15 in. thick, were lined with white metal to a thickness of 0·02 in by various makers and were subjected to a predetermined cycle of bending stress at a frequency of 3,000 per minute. No attempt was made to introduce a frictional resistance at the surface of the white metal, but to imitate the conditions of practice the tests were made at a temperature of approximately 120° C., and the surface of the white metal was covered with oil. Tests were also made on steel rings lined with lead bronze and supplied by the Allison Company of U.S.A. Finally, one of the lead bronze lined rings and a ring lined with Richards A.C.E. white metal were tested for coefficient of friction at various pressures and temperatures in the N.P.L. Journal bearing testing machine.

At various stages of the test the liner was examined and the progress of the cracks noted. The initial adhesion of the white metal to the steel was also measured by a method specially devised for the purpose. Comparison of the behaviour of white metal liners (1) cast and (2) centrifuged, was also made and the distribution of the constituents of the white metal due to centrifuging was investigated.

The tests of the strength of the static adhesion of the white metal to the steel indicated that in the best practice the adhesion was fully equal to the ultimate shear stress of the white metal.

Under long continued alteration of stress within the fatigue limit of the steel to which the white metal was attached, the surface of the latter rapidly became covered with a network of cracks, and in all the methods and materials tested, with the exception of the lead bronze, its adhesion to the steel was ultimately destroyed. In the best practice it was found that the complete destruction of the adhesion was only effected when the stress was a large fraction of the limiting fatigue stress of the steel and the number of repetitions of the order of 15 millions.

In the case of the steel rings lined with lead bronze supplied by the Allison Company, no apparent deterioration in adhesion and comparatively insignificant fatigue cracking of the liner was apparent after 15 million cycles of stress at a range of 18·9 tons per sq. in. It was clear that in both respects the merits of this alloy were of an entirely different order from those of the other so-called white metals. A very complete series of comparative tests in the N.P.L. Journal friction testing machine at high loads (up to 2,500 lb./sq. in.) and with various lubricants indicated a performance of the lead bronze under forced lubrication and continuous rotation which was fully equal to that obtained from one of the best tin base alloys.

# AIR TRANSPORT

## THE WIBAULT PENHOET 360 T. 5. MONOPLANE

FOLLOWING the successful introduction of his all-metal tri-motor, low wing transport monoplane, the **280** T, equipped with Gnome-Rhone **300** h.p., K.7, air-cooled motors, Mr. Michael Wibault has designed the **360 T. 5.**, a single engine tourist monoplane, which has just completed its series of tests at the Service Technique Aerodrome of Villacoublay, where it was presented by the constructors, the Chantiers Aeronautiques Wibault-Penhoet.

This plane has been specially designed for tourist use and also for light passenger and postal work on the air line systems, where economical speedy operation is desired. Of a low, thick wing of the cantilever type, this machine is constructed entirely of metal, and has accomodation for **5** people, including the pilot. It is designed to be equipped with a 230 h.p. Salmson air-cooled motor, or a **300** h.p. Gnome-Rhone air-cooled engine can be mounted, a considerable increase of speed being attained with the latter motor.

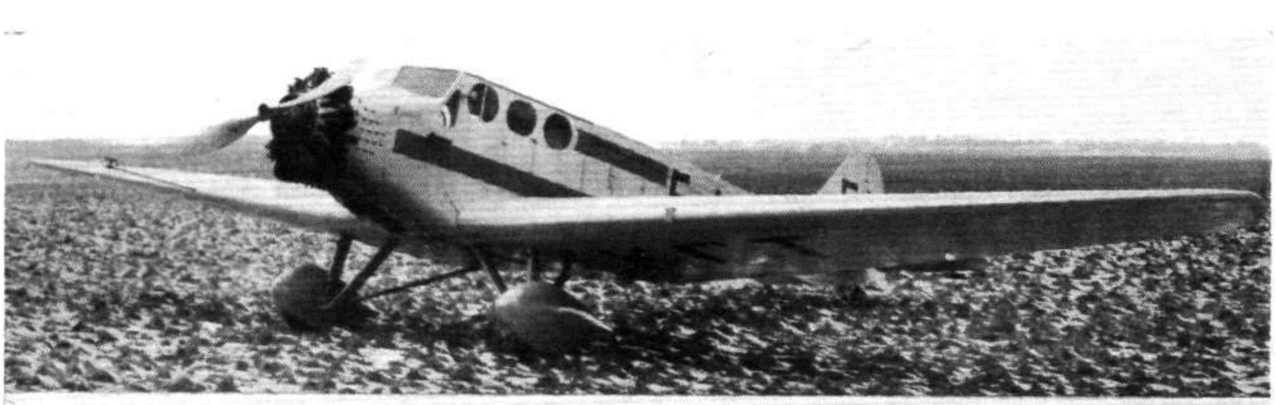
The detachable wings consist of a centre section, which forms an integral part of the fuselage, and to which the main wings are joined on each side in cantilever fashion. These are of trapezoidal form and mounted at a marked dihedral angle. The two longerons used in the construction of each wing are made of duralumin, and all the internal bracing throughout is of that same metal, while the wings themselves are covered with duralumin sheet. The construction of the tail is similar to that of the wings.

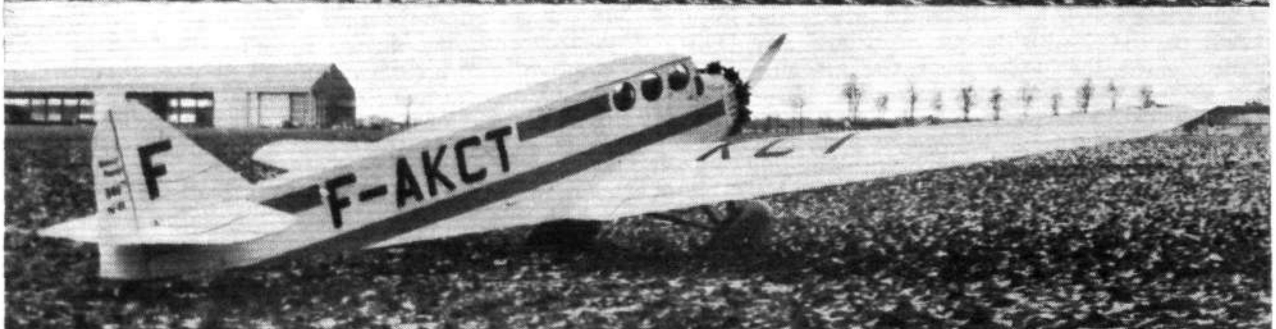
The fuselage is also of metal construction throughout, covered with duralumin sheet. The cabin, which is lighted by three large ports on each side, is furnished in the style of an automobile. There are two seats in front, placed side by side, the one on the left being occupied by the pilot, alongside of whom is a passenger. Three comfortable chairs are installed behind them. A good sized compartment, which has a capacity for 165 lb. (75 kg.) of baggage, has been constructed just aft of the cabin.

The landing gear is of the split axle type, fitted with oleo-pneumatic shock absorbers and brakes. The wheels are covered with stream-lined "spats," and the tail skid consists of a small wheel equipped with a hard rubber tyre and mounted in a free turning socket.

The following performance figures were obtained at the official trials at Villacoublay, with full load and 230 h.p. Salmson engine:—

| Altitude | Time of Climb | Maximum Speed | R.P.M. of motor |
|---|---|---|---|
| 0 | — | 202,88 k.p.h. (126 m.p.h.) | 1,715 r.p.m. |
| 1,000 metres | 5′ 51″ | 199,50 k.p.h. (124 m.p.h.) | — |
| 2,000 ,, | 12′ 20″ | 196 k.p.h. (122 m.p.h.) | 1,670 r.p.m. |
| 3,000 ,, | 21′ 30″ | 191,5 k.p.h. (119 m.p.h.) | — |
| 4,000 ,, | 34′ 13″ | 184,5 k.p.h. (115 m.p.h.) | 1,625 r.p.m. |
| 5,000 ,, | 55′ 06″ | 174 k.p.h. (108 m.p.h.) | 1,590 r.p.m. |






**THE WIBAULT PENHOET 360 T. 5. MONOPLANE: Three-quarter front and rear views of the new French Tourist or light commercial all-metal machine. Its clean lines are further emphasised in the front view at the top of this page.**

*Trials made for Navigation Certificate*

| | Minimum imposed | Performances effected |
|---|---|---|
| Height of obstacle cleared at 600 m. (1,968 ft.) from "take off" | 20 m (65 ft.) | 29,5 m. (96 7 ft. |
| Time of climb to attain an altitude of 360 m. (1,181 ft.) | 3 minutes | 2 minutes. |
| Speed at 9/10 nominal power | | 191 k.p.h. (118 m.p.h.). |
| ,, 1,500 r.p.m. | | 176,5 k.p.h. (110 m.p.h.). |
| ,, 1,300 ,, | | 151,35 k.p.h. (94 m.p.h.). |

The characteristics of the Wibault-Penhoet **360** T, with **230** h.p. Salmson engine, are:—

Span, **16,97** m. (**56** ft. **8** in.); O.A. length, **11,18** m. (**36** ft. **8** in.); height, **2,94** m. (**9** ft. **7** in.); wing area, **31,8** sq. m. (**342** sq. ft.).

*Weights.*—Machine empty, **1,272** kg. (**2,800** lb.); useful load, **628** kg. (**1,382** lb.); total weight, **1,900** kg. (**4,180** lb.). Item weights.—Engine, **360** kg. (**792** lb.); fuel tanks, **21** kg. (**46** lb.); miscellaneous fittings, **20** kg. (**45** lb.); fuel, **102** kg. (**224** lb.); general equipment, **11** kg. (**24.2** lb.); pilot and passengers, **440** kg. (**968** lb.); baggage, **75** kg. (**165** lb.). Power loading, **7,61** kg./h.p. (**16.8** lb./h.p.); wing loading, **60** kg./m.$^2$ (**12.3** lb./sq. ft.).

Ceiling, **5,000** m. (**16,400** ft.). Flight radius, **450** km. (**279** miles).

As designed for postal and light service operations on air line systems, the **360** T, with slight modifications, will be equipped with a **300** h.p. Gnome-Rhone K.7 engine fitted with a N.A.C.A. cowling. Thus, a commercial load of **670** kg. (**1,475** lb.) will be carried, together with **230** kg. (**70** gal.) of petrol. This will provide a flight radius of about **600** km. (**373** miles). The following performances, when equipped with this engine, have been obtained, unofficially.—Maximum speed, at ground level, **246** k.p.h. (**153** m.p.h.); at **1,500** m., **239** k.p.h. (**148** m.p.h.); at **2,000** m., **234** k.p.h. (**145** m.p.h.). Speed at **1,700** r.p.m., at ground level, **216** k.p.h. (**134** m.p.h.); at **1,500** m., **210** k.p.h. (**130** m.p.h.). Ceiling, **7,000** m.

R. C. W.

**Cape-Cairo Air Route Grant from Beit Fund**

The following statement appeared in *The Times* of February 24:—An announcement was made in Salisbury, Southern Rhodesia, yesterday, by Sir Alfred Beit, M.P., that the Beit Railway Trustees have agreed to set aside **£50,000** for the development of services directed towards the improvement of air transport along the Cape-to-Cairo route. Our Salisbury Correspondent telegraphs that the grant will be spread over two years and will come into operation next year. Consultations on the best method of spending the money will shortly take place between the Trustees and the Colonial Office, Air Ministry, Imperial Airways, and the local authorities. The Trustees, however, have definitely in mind the need for better aerodromes, the provision of emergency landing places and meteorological stations, and the development of wireless communications. A chain of meteorological stations has already been established in Egypt, the Sudan, Kenya, and in Tanganyika, but so far little has been done in Rhodesia. The Beit Railway Trust was formed under the will of the late Mr. Alfred Beit, one of the principal collaborators of Cecil Rhodes, who bequeathed **£1,250,000** for the development of railways and other means of communication along the Cape-to-Cairo route. Over **£417,000** has already been distributed by the Trustees in Southern and Northern Rhodesia. The Trustees are the Duke of Abercorn, Sir Henry Birchenough, Sir Drummond Chaplin, Sir J. G. McDonald, Baron F. d'Erlanger, and Sir Alfred Beit.

The last-named is personally interested in aviation, and he has been mainly instrumental in getting the new grant.

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# CORRESPONDENCE

***The Editor does not hold himself responsible for opinions expressed by correspondents. The names and addresses of the writers, not necessarily for publication, must in all cases accompany letters intended for insertion in these columns.***

## ENGINEERS AS PILOTS

[**2791**] A very interesting news item is to be found in the current issue of FLIGHT, under "Croydon," by P. B. The paragraph to which I refer is that relating to Imperial Airways' most commendable action in having some of her engineers trained as pilots. We progress.

For that *is* progress. The pilot of to-morrow is essentially a man who knows his kite from prop to rudder, and, when necessary, can take off his coat and "get down to it." He will have to be worth every penny of his salary to the firm by whom he is employed. British civil aviation, if it is going to hold its own—and by that I mean stand on its own feet—has got to forget to talk in pound notes and pay more attention to its ha'pennies and pennies. It will be unable to afford to "carry passengers" and "hangers-on" cn its staffs, as there has been a tendency to do in the past.

In spite of the fact that we can build the finest and fastest aircraft in the world, commercial aviation—by which title the whole of the flying activities of this country are designated—as an "aircraft," is deplorably "inefficient."

It has much too much parasitic resistance in the form of "manicured pansies," who do not contribute any "lift," and greatly retard the progress of the machine by the absorption of salaries which they have not earned. And, when I say earned, I mean by contributing something of practical value in return for the wages paid them.

Although joy-riding is, and has been, the only branch that can show a profit, it unfortunately created a table of false values for this reason. There were pilots, for instance, last year "on tour" with joy-riding "circuses," who were receiving extremely good salaries. In addition to which they received a commission and their expenses. Of course, they stayed at the "Grand" or the "Majestic," made going to bed well "under the surface" a matter of duty, and generally putting out the boat on a pretty hefty scale. And this isn't romance, it's reality. There are certain people connected with operating companies to-day, unfortunately, who are under the impression that aviation is Nature's excuse for having a good time.

Just look back into the history of joy-riding in this country, and what does one see? The whole of its field littered with wrecks of "Aviation" firms. Wrecked for the most part by rank rotten management, and spendthrift policies. The whole trouble has been that the majority of these firms have been inefficiently run by men with little or no business experience. They operated in the blissful belief that "the weather to-morrow will be O.K.," and spent their takings up to the limit. An error of judgment and a write off, or a spell of dud weather, and there was another joy-riding company up a gum tree.

Few people can realise how precariously some of these firms exist, and what a struggle it is to see the winter through. Ask some of their engineers and pilots who are given holidays, sometimes lasting from September until the next March! Do we have to look far to see evidence of this? We do not. A great many of these people "live on the posh" during flying days, and then in the "fall" and 'til the next spring eke out an existence on bread and jam! Who wouldn't be an airman?

Of course, the retention by a joy-riding company of the whole of its summer staff all the year round is impossible. But I do maintain that if more of these firms exercised greater economy during the operating season by fixing a standard rate for engineers and pilots—whether Captains or N.C.O.'s—arranging their bonuses on a freedom-from-crash basis instead of a commission, so that the employees help to bear part of their firm's risk, and in a dozen other ways following a more *thrifty* policy, they would have more money at the back end to expend on employment.

The pilots can come into the shops, stick on a pair of overalls, and help with the re-conditioning. Even if they are not paid as much as when they were flying, they will be in a job, that they would otherwise be hunting. There *must* be economies and sacrifices if civil aviation is going to get anywhere.

I do not suggest the use of inferior quality material as a means of cutting down expenses, but by putting that which is already available to a more useful purpose.

In future, if a man has the title or rank of Chief Engineer or Senior Pilot, he must be a "practical" man,

one who can do the job better than the rest, and not hold it simply by the virtue of his ability to dictate a letter, and speak with a public school accent; or because he has been fortunate in having someone exercising their influence. No. The people who actually do the job can hand in their reports to the manager themselves. The positions of intermediate figureheads are superfluous and a costly item in the wage accounts. Aviation only needs men who can *save* their firm expense, not help to incur it.

Therefore it shows foresight and business acumen on the part of Imperial Airways in having their engineers trained as pilots also. They are training men who learn the job from the ground up in a commercial sense, and who realise that their company's success and expansion is the jam on their bread and butter.

In conclusion, a word to the fellows who are or will be undergoing training. This is your "big change." Make the most of it; remembering that your success and abilities can have far-reaching effects. Bend your backs and stick into it, so that when you have had your innings the next man in will be proud to take the place of "a fine pilot and stout fella."

"Complete Overhaul."

Plymouth,
February 6, 1932.

### COMMERCIAL FLYING IN SIAM

[**2792**] I have read with much surprise the article on commercial flying in Siam, which appeared in your publication of November 27. I do not know who is the author, but he obviously is a person with a grievance which he has unfortunately aired in print. I do not think the inaccuracies and half-truths and generally critical tone of the article should go unchallenged.

As regards the statements made, it is said that "Government purchased a Curtiss 'Scout' and Bristol 'Bulldog.'" No Curtiss "Scout" has been purchased, while two (not one) Bristol "Bulldogs" are used by the Siamese Air Force. The lack of a "highly keen sense of imagination" on the part of the Siamese pilots is a fallacy. The number of accidents, fatal or otherwise, in the Siamese Air Force is remarkably low, and certainly compares very favourably with other countries. Don Muang Aerodrome is 23 kilometres from Bangkok and not 40 as stated.

The author refers to the "excellent piece of ground opposite the Royal Palace" in the city as a possible aerodrome. This can only apply to the Premane Ground, which is exactly opposite the Grand Palace and unthinkable as a possible aerodrome. Probably he confused the Royal Palace with the Phya Thai Hotel, which was formerly a palace of the late King. The ground in front of the Phya Thai Hotel is certainly large enough, but the work involved in preparing it for aviation purposes would be colossal. This is the reason there is no aerodrome in the heart of Bangkok, not inter-departmental friction, as the writer suggests.

He states that "after many delays operations were started." The first two machines did not arrive in Siam until July 15. The present Operations Manager did not arrive in Siam until August 15, and the Aerial Transport Co. commenced their regular service as from August 24, which was the date arranged in the previous April for the commencement of operations. This would not seem to justify his remarks about delay.

He complains that the machines were sent to Don Muang instead of Korat. The point in sending them to Don Muang was to assemble them there and fly them to Korat. However, for very good reasons known to the writer of this letter, it was decided later not to do that, but to send them by rail after erection.

He complains that the aircraft were assembled and tested "without reference to the foreign civil pilot." At that date the present Operations Manager had not arrived in Siam. In any case the reference is only to the first two machines. The second two "Puss Moths," owned by the Aerial Transport Co., were assembled and test flown at Korat under the present Operations Manager at the request of the Siamese Air Force, and in the absence of any Army official. Certificates of airworthiness were issued on the approval of the Operations Manager.

He also complains of the fact that the Government organisation of civil aviation was inadequate. This was true at the time, as there had been no civil aircraft or civil aviation in Siam up to that date. There was an air mail service in the North Eastern Provinces, but this was operated by the Royal Aeronautical Department with its own machines. However, this has all been looked after since, and now Siam has civil air regulations as carefully prepared and as rigorously enforced as any other country.

He states that of all the civil aerodromes listed, Korat alone was ready for use in July. Korat was *not* ready in July, and operations did not commence until November 1 from the civil field at Korat, but the Army gave full co-operation, and the first six months of the company's operations were on Army fields. Actually Korat and Nakon Pnom are the only civil fields in use, the remaining fields at Roi Etch Khonkaen, Udorn, Salakam, Nong Wen, Nong Harn Sakol Nakon, are all Army fields and have been consistently used throughout the wet monsoon. So far, despite his assertion that a landing on any one of them would "write off" an under-carriage or propeller, they have yet to damage their first machine. No damage has occurred to any of the aircraft in operations which already exceed 50,000 kilometres. The operating costs per kilometre flown are said to be the lowest of any air mail service in the world, and the volume of mail, despite the smallness of the aircraft to be exceeded by comparatively few air lines anywhere.

As regards the reference to the French air mail, the handling of this in Siam has now been entrusted to the Aerial Transport Co.

In six months' operations of the Aerial Transport Co. there have been no accidents of any description, no forced landings, a 100 per cent. record of schedule performances, and only three instances of aircraft being late in scheduled arrival at any aerodrome.

The company earns a profit without subsidy, and is paid for the mail it actually carries and not for miles flown. The Government of Siam is not faced with the necessity of voting money to make good its operating losses, as is the case in most air services throughout the world.

All this is being accomplished with strictly Siamese operating personnel in the way of pilots and mechanics, and their excellent record would seem to give the lie to the author's vague suggestions of inferiority.

In view of all that I have written, I think you will agree that the company deserves kinder treatment at the hands of your esteemed journal, and I am sure you will welcome the chance to make amends on the facts I have now placed before you.

"Fairplay."

Bangkok.
January 29, 1932.

[*The above letter is a good example of* "audi alterem partem" *and should, we hope, nullify any possible ill-effects which may have been created by the original article received by us from, as far as we could judge, a reliable correspondent and which should have been under the* nom de plume *of "Cabane." This was omitted by printer's negligence. We welcome the opportunity to publish the above letter from "Fairplay," who, we may say, represents an undeniably reliable source.*—Ed.]

**Indian Air Force**

Sir Samuel Hoare, Secretary for India, in reply to a question in the House on February 8, stated that nine Indian cadets were now at Cranwell and one under training at Kidbrooke. It was hoped to establish the first unit of the Indian Air Force in March, 1933.

**Irish O.T.C. to form Reserve of Pilots**

Part of a scheme for the building up of an Air Force Reserve in the Irish Free State is by the training of selected members of the University Officers Training Corps, writes our Dublin correspondent, and a number of them will be drafted to Baldonnel Aerodrome for instruction during the summer months. It is understood that an order for the supply of six Avro Trainers of the latest type has been passed by the Department of Defence, and these will be used for the training of the Reserve. It is also learned that an officer will be sent from the Free State Army Air Corps to the Central Flying School of the R.A.F. for training. Another part of the Reserve plan is the drafting of regular officers from other branches of the National Army for tuition as pilots and for schooling in army co-operation work. This section of the scheme has been temporarily held up, presumably as an economy measure.

# AIRPORT NEWS

## CROYDON

THE advertised Capetown Air Mail arrived on Tuesday, nine days late. The Handley Page 42 "Helena" brought the mail from Paris, the identical machine to take the first outward mail, as far as Paris. So the uninitiated who witnessed both the departure and arrival of this machine really thought that "Helena" had flown to the Cape and back. Capt. O. P. Jones, who has been flying on the African route, came back as a passenger, with a beautifully cultivated beard.

On Thursday a certain lady flew to Paris for the purpose of changing her religion in mid-air. The change from the Christian faith to the Moslem took place while flying over the Channel. She was accompanied by three or four Press photographers as well as other passengers. This ceremony had a beneficial effect on passenger bookings; it certainly was a good advertisement for Imperial Airways.

Passenger traffic seems exceptionally good for the time of year, and augurs well for the coming summer season. It is to be hoped that sufficient machines will be available this season to meet the demand, and that services will run to schedule, with spare machines standing by for cases of emergency. If the airline companies see to it that spare machines are in readiness, it would be possible to avoid keeping passengers waiting while some repair is being effected.

I should like to draw the attention of Air Union to a few points regarding the loading and unloading of their machines. It would seem to be a habit of the company to have the propellers running while the men are working. Surely a serious accident to a mechanic or porter should not be necessary to get this dangerous habit stopped. There is always a possibility of a slip off the steps, or, fully occupied with a task, of walking into one of the propellers. Accidents of this nature *have* occurred, and it is to be hoped that the revving of propellers during the loading and unloading of machines will be regarded at no distant date as a breach of regulations. The best of men have moments of forgetfulness!

The British Air Transport School of Flying has now 23 pupils, of which 19 are being trained for commercial licences. The company has had extraordinary success since inaugurating its new system of training, which is based on the principle that a pilot's "job" is not the sole object of a knowledge of flying. The company have realised that civil aviation in its administrative branches offers a career to young men which is unequalled in any other profession of the day. We hear that the demand for the services of the British Air Transport Company is increasing to such an extent that they are making arrangements to open a branch of their Flying School on the South Coast.

The traffic figures for the week were:—Passengers, 521; freight, 31 tons.

P. B.

## HESTON AIR PARK

F-AJOO, the "Moth" of the B.P. (France) Petrol Co., which was sent to Heston for her C. of A. overhaul, was returned to Paris on February 16.

On Wednesday, February 17, the coming generation were assisted to become interested in aircraft by Mr. Nigel Norman, who showed round a party of some 40 Dulwich College boys. Many of these were taken up by Flt. Lt. Russell on a Redwing, Capt. Baker on a "Moth," and Mr. Stace on an "Avian." On Friday, February 19, Mr. Nigel Norman also gave a lecture to the boys at their college.

On Thursday, February 18, there occurred an incident which may, it is hoped, establish a precedent. The Imperial Airways H.P. 42 (G-AAXE), due to arrive at Croydon somewhere about 10.30 a.m., found both that aerodrome and also that of Penshurst were in fog. He was therefore ordered by wireless to land at Heston; this he did successfully. Within ten min. of landing all the passengers had cleared Customs and were on their way to London by an Airwork car. The advantage of this method over the old one of using the landing ground at Penshurst is very obvious. At Penshurst there are no Customs facilities, and an officer has to be fetched from Tonbridge. A car to convey the passengers has also to be sent from Croydon, the total delay in such cases being anything up to three hours or more, whereas by landing at Heston it is quite possible that the passengers were in London even sooner than they would have been if they had landed at Croydon.

Maj. Clarke, of Personal Flying Services, recently established what must be a record for the trip to Abbeville and back, on his firm's Hendy 302 (Hermes). He flew there, picked up a press representative who had been photographing "a lady changing her faith in the air," during the passage of an Imperial Airways machine to Paris, and returned to Heston in exactly three hours from the time he left. Let us hope that the change of faith was coupled with an increase of faith in air transport, and that thus out of this much advertised stunt we may gain yet another disciple.

On February 19 Mr. M. A. G. Scally arrived somewhat late from Dublin, and due to the fog and dusk was unable to make the aerodrome. He pulled off a successful forced landing, however, in a field near Slough, and came on to Heston the following morning. His machine, a Comper Swift (Pobjoy), is the first aircraft with Irish Free State registration letters which has cleared Customs at Heston on its way to the Continent.


**MAROONED IN THE SAHARA: The three French pilots (left to right) Touge, Reginensi and Lenier and their Farman monoplane just before they started out from Le Bourget on a flight to Madagascar. As previously reported they were forced down in the Sahara and were "lost" for several days.** *(Photo—Andre, Courtesy Shell-Mex & B.P., Ltd.)*

# AIRISMS FROM THE FOUR WINDS

**Hamilton and Coupland Crash**

Flt. Lt. Leslie Hamilton and F/O. R. K. Coupland left Lympne on February 18 in a "Puss Moth" for Australia. They reached Rome at 12.18 p.m. next day and left again at 4.5 p.m. for Athens. They got lost in a fog that night and crashed into a hillside near Ruvo di Puglia, in Apulia. Both were slightly hurt. No news was received of them for four days, but some peasants found them on Monday, the 22nd, and they were conveyed to hospital.

**Fatal End to Ireland-India Flight**

Mr. G. A. Scally, a member of the Irish Aero Club, who left Baldonnell Aerodrome, Dublin, in a Comper "Swift" on a flight to Ceylon on February 18, met with a fatal accident during the early stages of his flight. After leaving Lyons on the afternoon of February 21 he got into difficulties when flying low over Berre, Marseilles, and the machine crashed to the ground. Mr. Scally was removed from the machine unconscious and seriously injured, and conveyed to St. Pierre Hospital, where he died that evening.

**Mr. Ulm Injured**

Mr. C. B. Ulm—who flew with Air Commodore Kingsford Smith across the Pacific—and Mr. J. A. Kerr were seriously injured when their Avro "Avian" crashed into some high-tension cables while flying from Sydney to Melbourne on February 21.

**R.A.F. East African Flight**

The R.A.F. East African flight arrived at Dar-es-Salaam, the port of Tanganyika, on Saturday, February 20.

**The "Morning Post" Race**

On May 21, unless it is found necessary to change the present arrangements, there will be a unique race starting from, and finishing at, Heston. This is being organised by the *Morning Post*, and the rules which are now under discussion will probably be formulated so as to make the race a test for map reading and cross-country navigation. It will be a handicap race, and most likely of one day duration only. It will be limited to civil aircraft, and if found practicable, to pilots of genuine amateur status, at any rate, pilots holding "B" licences will not be allowed to enter.

**Aircraft in the Shanghai Fighting**

Reports from Shanghai make frequent mention of aircraft, chiefly Japanese aircraft, but contain very little news of the results of their activity. On February 11 a bomb was dropped on a mill in the American sector of the International Settlement. The Japanese Admiral apologised for the mistake, and added that aircraft would be forbidden to fly over the International Settlement. One correspondent says he saw 50 Japanese aircraft of all sizes on an aerodrome, and mechanics fitting 250-lb. and 500-lb. bombs in their racks. On February 22 the Japanese claimed to have bombed and wrecked the Chinese aerodrome at Haugjao, destroying the hangars and machines; to which the Chinese replied that the aeroplanes there were all obsolete, which is probably true. On the same day, an American named Robert Short, in the Chinese service, attacked three Japanese aeroplanes over Soochow. Short was shot down in flames, but one of the Japanese pilots, Susumu Kotani, died of his wounds next day. After seeing Short fall, the three Japanese machines dipped in salute to a brave man.

**Aircraft on Submarines**

In reply to questions in the House on February 17, the First Lord of the Admiralty stated that no decision had been reached as to whether experiments with aircraft in submarines would be continued. The weight of the seaplane structure (hangar and catapult) fitted to the lost M.2 was 40 tons, as compared with 120 tons in the same vertical position as originally designed for a 12-in. gun. The M.2, since the fitting of the seaplane structure, had proved very easy to control and trim in all conditions.

**Mr. H. T. Vane Leaves Napiers**

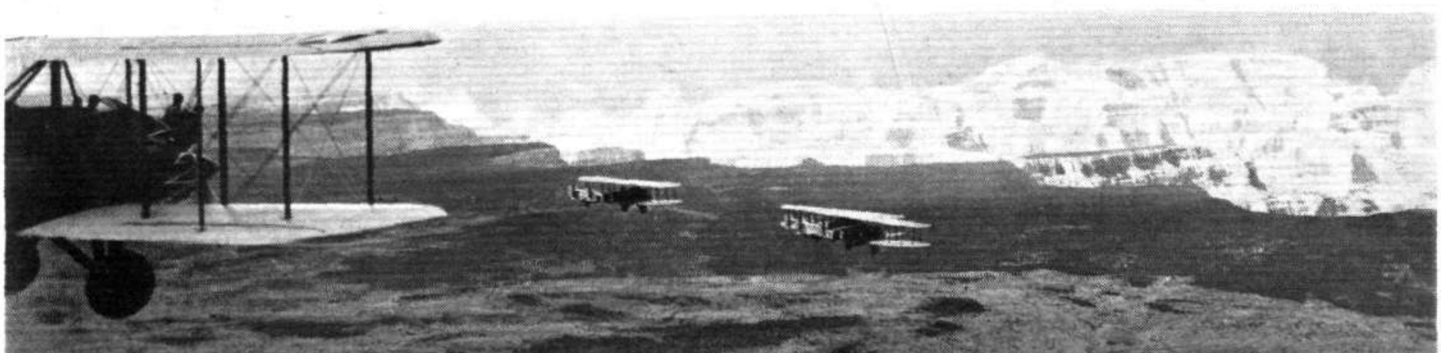
D. Napier & Son, Ltd., announce that in consequence of Mr. H. T. Vane, C.B.E., being unable to concur in the views of the board regarding the future business policy of the company, arrangements have been made with him for the termination of his agreement as managing director, which would otherwise expire in June, 1933, and he has also resigned the office of chairman of the board, to which he was elected for one year as from April 1, 1931.

**The "Akron" Damaged**

On February 23 the U.S. Navy airship *Akron* was being walked out of her shed to take a party of politicians for a flight when it was caught by a gust, rose about 20 ft. into the air, and bumped on the ground. The lower vertical fin and rudder were smashed and some of the transverse rings were bent. Two ratings of the ground party were injured.

**"Cutty Sarks" for China**

Saunders-Roe, Ltd., of East Cowes, have received an order from the Far-East Aviation Co., Ltd., for two 1932 model Saro "Cutty Sark" amphibians for land, water and air operations from Hong Kong. These amphibians are four-seaters and are fitted with two Armstrong-Siddeley "Genet Major" engines. They will be tested at Cowes and despatched to China during April.



**OVER THE GRAND CANYON: A flight of Curtiss "Condor" Bombers of the U.S. Army Air Corps shown on their way over the Grand Canyon, North Arizona, to the relief of Navajo Indians who were isolated by heavy snowfalls recently.**

# German and British Experts Disagree

*The Deutsche Versuchsanstalt für Luftfahrt has now published its report on experiments and researches carried out to check the findings of the British inquiry into the accident to the Junkers F.13 G-AAZK at Meopham, Kent, in 1930. The D.V.L. finds itself unable to agree with the British view that the accident was due to tail "buffeting."*

PROBABLY most of our readers will recollect that, as a result of the inquiry into the air crash at Meopham, Kent, on July 21, 1930, in which several people were killed, the British experts arrived at the conclusion that "buffeting" caused the tail to break, the breakage of the wings and the tearing away of the engine from the machine being subsequent events. German representatives came to England at the time of the crash and examined the wreckage. On their return to Germany they drew up a report in which the main conclusion was that the machine accidentally got into a steep dive in the clouds known to have prevailed over the district on that day, and that in pulling out too suddenly and at high speed, stresses were set up in the wings which proved too great, and the wings collapsed. In the German view, the tail breakage followed the wing breakage and did not precede it. What lent strength to the German view was that a very similar accident had previously taken place, in which the observer was saved by parachute and was able to corroborate the evidence of eye witnesses on the ground.

The present German report—or such portions of it as have become known in this country through publication in the "Z.F.M."—is concerned not with assigning the primary cause of the accident, but with testing the probability of the British theory being correct. This work has been undertaken in an extremely thorough fashion by static tests on tails in the laboratory, by flying tests on actual aircraft of the same type, by vibration tests of tails, and by tests of models in the wind tunnel.

Space does not, unfortunately, permit of referring in detail to the German researches and experiments upon the results of which the German view is based. The work contains much that is of interest to aircraft designers in all countries, even if its main result is of a somewhat negative character in that it expresses what is *not* likely to have happened. We must confine ourselves to giving the merest outline of the experiments made, and do so in the hope that this brief summary will at any rate serve to show the thoroughness with which the work was undertaken and carried out, and that the practical ruling out of the British theory was only arrived at after the most painstaking efforts to get at the truth.

### The D.V.L. Experiments

*Static and Dynamic Tailplane Tests.*—Static tests of tailplanes were carried out in the laboratory, and were made with the machines so arranged that the undercarriage wheels were rigidly held and the tail skid supported on a universal ball bearing, so that free movement in all directions was afforded. The tests included symmetrical and unsymmetrical loading and gave failures at bending moments of 310 mkg. (2,233 ft. lb.) and 388 mkg. (2,800 ft. lb.). The difference in the results was due to the spars of one tailplane being of slightly heavier gauge than the other. In both cases the breaking stress was 35 kg. per sq. mm. (51,333 lb./sq. in.).

Dynamic tests were also carried out in the laboratory in order to determine how the tail would behave when vibrations corresponding to the natural frequency of the tail were set up and permitted to build up. The amplitude corresponding to breakage was reached in about 300 vibrations, or about 25 seconds. Breakage occurred when the double amplitude measured at the tip of the tailplane reached 12.5 cm. (about 4.9 in.). The bending moment causing breakage was calculated to be 255 mkg. (1,840 ft. lb.), and the maximum stress developed was about 85 per cent. of that of the static tests.

The tail which had been broken in the dynamic loading tests was subjected to static tests. Although the spar was broken, and the tail only held together by the metal skin covering, the tail was so placed that the undamaged spar boom was in tension, and in this way the tail supported a load of 125 kg. (275 lb.) at each end of the tailplane.

The conclusions from these tests were that if breakage is brought about by high dynamic loads (resonance), the natural period of the tail is at once lowered to the point where resonance no longer occurs. As the strength of the tail under static load is still 60 per cent. of the original, it is concluded that complete static breakage can only take place under specially unfavourable circumstances.

Fatigue tests were arranged to correspond to a bending moment of $\pm$ 74 mkg. (534 ft. lb.), or 24 per cent. of the static bending moment leading to breakage. After approximately 700,000 vibrations the metal covering began to crack, indicating that a breakage was imminent.

*Actual Flying Tests.*—To determine the air flow between wing and tail, the vibrations of the tailplane, and the forces in the tailplane struts, a machine was prepared specially for a series of flight tests. It carried a slow-motion cinematograph camera and an optograph, as well as woollen threads, smoke-producing apparatus, etc., to give visual indication of the air flow. We have not the space to describe in detail this interesting equipment, but must content ourselves with giving the bare results obtained. The flight tests indicated clearly that the slipstream had a great effect on the airflow, and that, with engine throttled right back, the air disturbances and the tailplane vibrations were much more pronounced than with engine only slightly throttled. In one of the flight tests pronounced "buffeting" set in during a side slip to the right. This was not expected from previous experience, and but a small portion of the latter part of the "buffeting" was filmed. The pilot (not unnaturally) righted the machine in a hurry, and subsequent attempts to reproduce the same conditions failed. From this fact it is concluded that a very special set of conditions of speed, slipstream, gustiness, acceleration and yaw is necessary before "buffeting" can be produced. The flying experiments indicated that vortices are shed by the wing roots on to the tailplane in an unsymmetrical manner, and that the vortices increase with angle of incidence and angle of yaw. The tailplane "buffeting" was experienced in all flying conditions in which vortices from the trailing edge of the main wing were determined, and more particularly during stalled flight or flight at large angles of yaw. The tailplane vibrations were irregular both in amplitude and frequency, and a gradual building up of large amplitudes during a series of vibrations was rarely found. On the other hand, large amplitudes in the form of single vibrations, or a short series of vibrations, were found more frequently. Asymmetry was found at the frequency of torsional vibrations and symmetry at the frequency of bending vibrations. The amplitude increased slowly with speed, but did not reach its maximum at any given speed. The worst double amplitude reached was of approximately 9 cm. (3.5 in.), corresponding to about 30 per cent. of the breaking strength determined in the static tests.

*Wind Tunnel Experiments.*—As a result of wind tunnel tests on models, it was concluded that resonance between the frequency of the vortices shed by the wings and the natural period of the tail increased tailplane buffeting considerably. The results of the German model tests do not agree with the English tests, and the view is expressed that this may be due to the fact that in the British tests the wings of the model had to be "clipped" to enable the tests to be made on a large model in a small tunnel. Also, in the British tests the airscrew was absent, while the German tests were made with airscrew running. It is thought that this fact throws considerable doubt on the probability of the British theory of tail "buffeting" as the primary cause of the accident.

The report concludes with the statement that while tailplane breakage due to "buffeting" is not entirely ruled out as an explanation, its occurrence is so unlikely as to be practically ruled out, and in the present state of the technique it cannot, and need not, be designed for. The theory advanced by Hermann Blenk and Heinrich Hertel shortly after the accident, that the wing broke first as a result of too rapid pull out of a dive, is regarded as more probable, and calculations have shown that at a diving speed of 215 km./h. (134 m.p.h.) the pilot can pull out rapidly enough to break the wings.

# THE INDUSTRY

## HOYT ANTI-FRICTION METALS

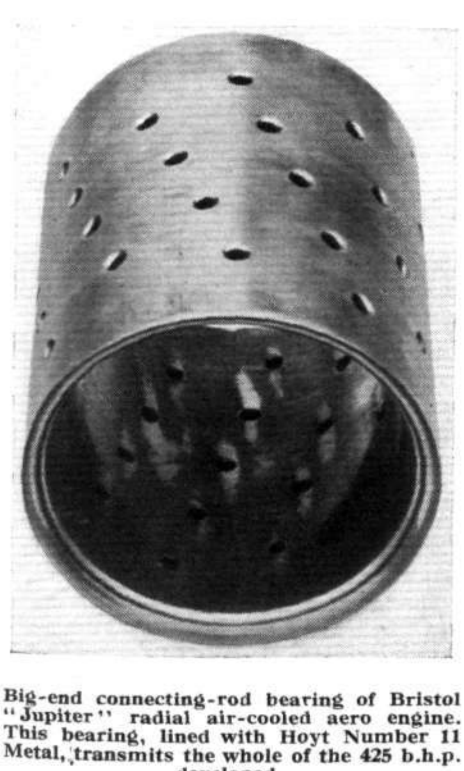
ONE of the most original of the many house organs which provide us with serious reading and useful information is the quarterly issued by the Hoyt Metal Co. of Great Britain, Ltd., appropriately called *The Notched Ingot*.

It is devised and written by the staff, and its editor, Mr. A. W. Jenner, realises what too many house-organ editors fail to realise, namely, that although the organ is produced primarily as a propaganda medium for the firm's manufactures there is no reason why it should fail to reach a high level of entertainment. We commend *The Notched Ingot* for two reasons in particular. It scorns those personal fatuities usually sub-titled "What We Want To Know," which never concern anyone except the members of the firm and probably embarrasses some of them, and its contents, both in text and illustrations, reach an historical and educational standard which undoubtedly makes the magazine of permanent value to the workers in the metal industry.

No. 10 issue of this quarterly, which is before us, has an engraving on its cover of an old-time craftsman at his work, and the engraver has made several errors, which gives the knowledgeable reader the amiable task of detecting them. Other interesting features include the tenth of a series on metal workers of a century ago, an article eulogising the importance of the carpenter's craft in the past (this is an example of the editor's impartiality), and an opening article of a new series on the lined bearing.

### "Number Eleven"

Hoyt Number Eleven metal as an anti-friction lining for bearings has, of course, been utilised in the aircraft industry from the beginning. It established a reputation for itself in the old 100-h.p. "Green" engine about 1911, and it found its heyday during the Great War. About 50,000 engines of one particular type used this material, and in 1918, for example, about 1,750 tons of Number Eleven were contracted for 250,000 engines.



**Big-end connecting-rod bearing of Bristol "Jupiter" radial air-cooled aero engine. This bearing, lined with Hoyt Number 11 Metal, transmits the whole of the 425 b.h.p. developed.**

This tough, durable lining is free from zinc, aluminium and lead, its specific gravity is 7.31, and weight per cub. in. 0.264 lb. "Standard" tin, not being considered good enough for high-grade alloys, the manufacturers of Number Eleven therefore use Straits, Banca, or English Refined for their greater purity.

In the lining of bearings for aero engines (particularly for connecting-rods) especial care has to be taken. Melted-down turnings must not be used, for example, and it is best that the metal be heated *once* only. Great care is necessary to avoid overheating the steel of the connecting-rod and so lowering the temper. The adhesion to the steel must be absolutely perfect all over, including right up to and over the edges ; in fact, not a spot must be missed. A high standard of craftsmanship is, indeed, required throughout the process.

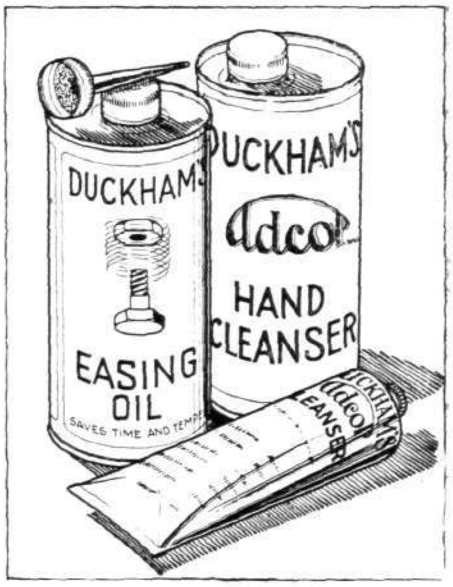
Before this particular work for aero engines is attempted, and essentially in the absence of previous experience, it is advisable to obtain the correct pouring temperatures from the Hoyt Company, informing them of the types of bearings to be handled.

### Instructions on Lining Bearings

They issue a very informative book containing the procedure for lining bearings, though in some respects the directions given do not apply when using Number Eleven for aero-engine bearings. Emphasis is laid upon the need for great care in avoiding overheating the white metal in the melting pot, and upon the extreme importance of stirring all anti-friction metals well and frequently.

There is also a warning never to mix different makes or qualities of white metal, and not to use old metal from bearings. Provided Hoyt metals are not overheated they may be re-melted when necessary, with the periodical addition of new metal, without injury resulting, but the fewer times the better. A lined bearing should ring true when touched with a light wooden object, and if it does not, then it means that the white metal is not adhering everywhere, and must be run out. Shells may not ring sound when impregnated with oil or are cracked or have a lot of holes or grooves, and in such cases discretion must be used.

If after tinning the white metal does not adhere to a bearing the tinning has been oxidised by making the shell too hot or not hot enough. Such are a few of the useful observations contained in the *Hoyt Book on the Lined Bearings*, which will be sent in response to *bona-fide* inquiries. The address of the Hoyt Metal Co. of Great Britain, Ltd., is Deodar Road, Putney-on-Thames, London, S.W.15.




**Duckham's "Easing Oil" (left) and Hand Cleanser (right) in tin and tube.**

## DUCKHAM'S AIDS

EVERYONE who is associated with work upon aircraft and aircraft engines, or for that matter those who have to sit at a desk either at the City or in the aircraft factory, will welcome the advent of a preparation which is guaranteed to clean their hands in an exemplary manner regardless of what dirt is ingrained therein.

### A Hand Cleanser

Duckham's "Adcol" hand cleanser is an extraordinarily efficient preparation. The ease with which it removes oil, grease, wet paint, ink, dirt and the grime of London's chimneys is little short of magical. The makers affirm that it contains no soda, grit or other roughening substance, and we can assure readers that after use the hands feel exactly as if one had used ordinary soap, not, as is the case with many hand-cleaning preparations, ordinary soap mixed with road grit and sand. This Hand Cleanser is also of great use for cleaning anything which is greasy, such as bowls and other household utensils, and it has the added advantage that, if necessary, it can be used without water. It is made up in tins for those who require a considerable amount of it or in collapsible tubes where such are convenient, as, for example, to carry in an aircraft or a car.

### For Difficult Lubrication

Another preparation of Duckham's is their Easing Oil. This is a penetrating fluid which will free any metal parts seized by rust or corrosion ; even nuts which have become permanently corroded on to bolts and on which the spanner has proved abortive will be found to yield to the gentle treatment of a few drops of Easing Oil. Anyone who has once tried such an oil as this will readily be able to think of many other uses to which it can be put.

### Preventing Corrosion

It is the standard practice in aircraft to protect flying wires and other bright metal parts from corrosion. An excellent preparation for this purpose

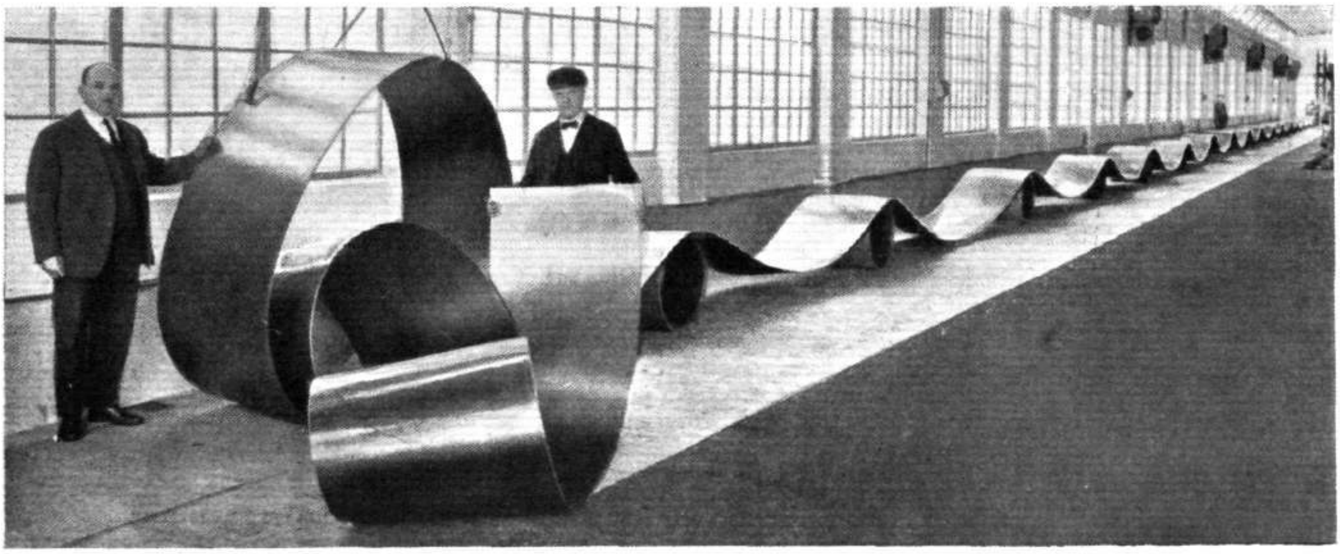
is Immutol Slush, also made by Alexander Duckham. It dries quickly, is entirely unaffected by the changes of temperature, even the extremes of hot or cold, and is absolutely waterproof. Another great advantage of this Slush is that, if desired, it may be supplied in red, blue, green, straw or colourless. As a measure of its suitability for the purpose, we might mention that it was used and specified by the Air Ministry as far back as 1914.

All these preparations can be obtained from dealers all over the country or from Alexander Duckham & Co., Ltd., Duckham House, Cannon Street, E.C.4.

## COLD-ROLLED STRIP

STRIP steel is rapidly becoming of great importance in the manufacture of aircraft. At the Sandvik works in Sweden, whose London agents are the Sandvik British Agency, Ltd., Norwich Union Chambers, Congreave Street, Birmingham, cold-rolled steel strip has been manufactured since 1883.

Naturally, such an old-established factory has consistently kept abreast of modern developments, and we were, therefore, not unduly surprised to learn that they are able to manufacture strip up to widths of 32 in. (800 mm.), and even in this width in lengths of as much as 360 ft., while, if it is necessary, the thickness of small widths of strip may be reduced to 0.00012 in. (0.003 mm.). This steel is, of course, made from the pure Swedish ores, and is particularly uniform and pure throughout the ingots. A departure which should also interest the aircraft manufacturer is the ability of these works to produce tapered strip steel, for it is obvious that tapered metal may greatly simplify the manufacture of wing spars, especially to the most economical limits.



**A cold rolled, hardened and tempered steel band, 32 in. (800 mm.) wide, 0·047 in. (1·20 mm.) thick, and 360 ft. (110 m.) long. This is the sort of strip which can be obtained from the mills at Sandviken.**

# MODELS

### SOCIETY OF MODEL AERONAUTICAL ENGINEERS (S.M.A.E.)

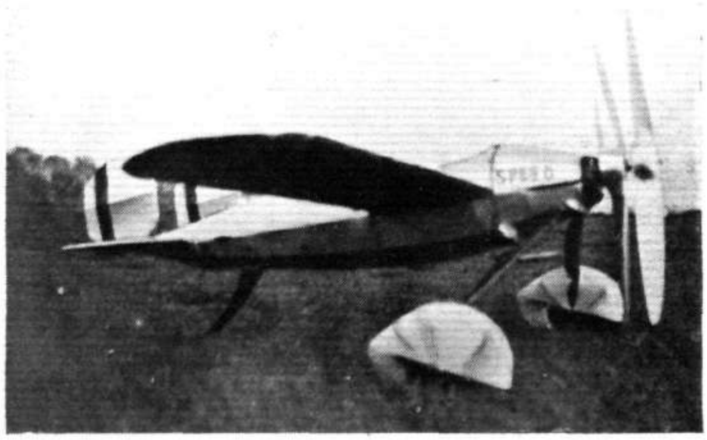
THE Annual General Meeting of the Society of Model Aeronautical Engineers will be held at the Y.M.C.A., Tottenham Court Road, London, W.C., on Thursday, March 10, at 7.30 p.m.

Any nominations for the posts of officers and council of the Society should be sent at once to the Hon. Secretary, S. G. Mullins, 72, Westminster Avenue, Thornton Heath, Surrey.

### THE MODEL AIRCRAFT CLUB (T.M.A.C.)

INDOOR Competition for Scale Model Aeroplanes, Horticultural Hall, on April 1, at 7 p.m. A prize of £2 2s. has been given by Mr. H. B. Pratt for this competition, which will be governed by the following rules:—(1) The competition is for Scale Models of any type of full-size aeroplane. Scale not exceeding 1 in. per foot. (2) Each competitor will be allowed three flights, the model to take off the ground under its own power. The best of the three flights to count for performance points. (3) Points to be awarded on the following basis:—Resemblance to type, appearance and approximate scale measurements (maximum 50 points); take-off, stability in flight and landing (maximum 25 points); workmanship and finish, performance, duration seconds (maximum 25 points).

The competition is open to members of the Model Aircraft Club. In the event of a competitor being unable to attend in person, arrangements will be made for the model to be flown by proxy. Intending competitors should send full particulars of their entry to the Competition Secretary, Mr. T. Newell, 32, Veroan Road, Bexley Heath, Kent, not later than March 16, 1932. The 1932 programme is in the printer's hand, and all members will be receiving one at an early date.



**ORIGINALITY: An experimental high-speed model designed and constructed by Mr. F. M. A. Hughes (T.M.A.C.), fitted with twin tandem airscrews to overcome torque. In trials with this model a speed of over 35 m.p.h. has been attained. This model was exhibited at the recent Models Exhibition, and was awarded 1st Prize in its Class.**

# THE ROYAL AIR FORCE

*London Gazette, February 16, 1932.*

*General Duties Branch*

Flying Officer A. N. Spottiswoode, R.A.F.O., is granted a short service commn. as Pilot Officer on probation with effect from and with seny. of Feb. 4; Pilot Officer on probation R. J. Bennett is confirmed in rank (Jan. 27). The following Pilot Officers are promoted to rank of Flying Officer:—D. R. S. Bader, J. W. C. More, G. D. Stephenson (Jan. 26); J. W. Bateman, E. J. Gracie, A. J. McDougall, G. N. Snarey, M. R. D. Trewby (Jan. 27); N. B. Littlejohn, W. F. Pharazyn, C. H. Smith (Jan. 28). Flying Officer V. J. Sofiano is promoted to rank of Flight Lieut. (Feb. 3); Flight Lieut. D. H. Carey is placed on the half-pay list. Scale B, from Jan. 28 to Jan. 30, inclusive.

The following Lieutenants, R.N., Flying Officers, R.A.F., cease to be attached to the R.A.F. on return to Naval duty (Jan. 31):—J. E. Burstall, C. A. N. Hooper.

Wing Commander E. R. L. Corballis, D.S.O., O.B.E., is placed on retired list at his own request (Feb. 8); Flying Officer G. C. Holland is placed on retired list on account of ill-health (Feb. 11); Flight Lieut. G. Bowen is placed on retired list (Feb. 14); Flying Officer C. P. Barker is transferred to Reserve, Class C. (Feb. 3); Flying Officer A. T. C. Hazledine relinquishes his short service commn. on account of ill-health (Feb. 10). The following Flying Officers relinquish their short service commns. on transfer to Royal Australian Air Force Reserve (Feb. 14):—C. R. Clarke, J. H. Lindell, J. F. McKenna, D. T. Saville. Flying Officer G. E. Klein relinquishes his short service commn. on completion of service (Feb. 14).

*Medical Branch*

Flight Lieut. H. C. S. Pimblett, M.B., B.S., is granted a permanent commn. in this rank (Feb. 17).

### ROYAL AIR FORCE RESERVE
### RESERVE OF AIR FORCE OFFICERS

*General Duties Branch*

Flying Officer L. C. L. Murray, Royal Australian Air Force Reserve, is granted a commn. in Class A as Flying Officer on probation (Dec. 30, 1931); Flying Officer G. E. Klein is granted a commn. in this rank in Class A on relinquishing his short service commn. in R.A.F. (Feb. 14); Pilot Officer J. C. Ticehurst is promoted to rank of Flying Officer (Jan. 7); Flying Officer F. W. Brown is transferred from Class B to Class C (June 2, 1931); Flying Officer N. W. Wale is transferred from Class C to Class B (Sept. 18, 1931); Flying Officer A. Cairnie is transferred from:—Class A to Class C (May 15, 1931), Class C to Class A (Jan. 16); Flying Officer D. S. Purnell relinquishes his commn. on completion of service (Oct. 26, 1931); Flying Officer A. H. Barnard relinquishes his commn. on completion of service and is permitted to retain his rank (Sept. 12, 1931); Flying Officer A. N. Spottiswoode relinquishes his commn. on appointment to a short service commn. in R.A.F. (Feb. 4).

### SPECIAL RESERVE

*General Duties Branch*

Pilot Officer W. Humble is promoted to rank of Flying Officer (Jan. 27); Pilot Officer C. N. Shaw is granted hon. rank of Flying Officer (Nov. 16, 1931). (Substituted for *Gazette*, Feb. 2.)

### AUXILIARY AIR FORCE

*General Duties Branch*

No. 600 (City of London (Bomber) Squadron.—The following Flying Officers are promoted to rank of Flight Lieutenant (Dec. 6, 1931):—P. G. Stewart, A. B. Ferguson.

No. 604 (County of Middlesex) (Bomber) Squadron.—Pilot Officer I. G. Statham is promoted to rank of Flying Officer (Dec. 28, 1931).

## ROYAL AIR FORCE INTELLIGENCE

**Appointments.**—The following appointments in the Royal Air Force are notified:—

*General Duties Branch*

*Wing Commanders*: J. C. P. Wood to No. 22 Group H.Q., S. Farnborough, 4.2.32, for Engineer Staff Duties vice S/Ldr. T. F. Bullen, O.B.E. T. V. Lister to H.Q., Coastal Area, Lee-on-Solent, 4.2.32, for signals duties vice W/Cdr. L. T. N. Gould, M.C.

*Squadron Leaders*: T. Q. Studd to R.A.F. Base, Calshot, 31.1.32, for Navigation duties vice W/Cdr. J. C. P. Wood. R. Halley, D.F.C., A.F.C., to No. 23 Group H.Q., Grantham, 1.2.32, for Personnel Staff Duties vice S/Ldr. T. Q. Studd. A. S. G. Lee, M.C., to Air Ministry (D.O.S.D.), 4.1.32, for Air Staff duties vice S/Ldr. H. K. Thorold, D.S.C., D.F.C., A.F.C. A. P. Ledger, M.B.E., to No. 1 Air Defence Group H.Q. and attached Air Ministry (D.O.I.), 1.2.32. W. E. G. Bryant, M.B.E., to No. 25 (F) Sqdn., Hawkinge, 8.2.32, pending taking over Command. R. E. G. Fulljames, M.C., to H.Q., Fighting Area, 7.2.32, for Engineer duties vice S/Ldr. T. C. Thomson. H. O. Long, D.S.O., to Aeroplane and Armament Experimental Estabt., Martlesham Heath, 8.2.32, for Engineer duties vice F/Lt. A. F. Scroggs. G. H. Hall, A.F.C., to No. 10 (B) Sqdn., Boscombe Down, 15.1.32, for flying duties vice S/Ldr. W. A. C. Morgan, M.C. F. H. Laurence, M.C., to Central Flying School, Wittering, 8.2.32, for flying Refresher Course. T. F. W. Thompson. D.F.C., to No. 500 (County of Kent) (B) Sqdn., Manston, 8.2.32, for flying duties vice W/Cdr. S. R. Watkins, A.F.C.

*Flight Lieutenants*: J. A. MacNab to R. A. F. Depot, Uxbridge, 25.1.32. R. L. Sweeny to Station H.Q., Upper Heyford, 8.2.32. L. E. M. Gillman to R.A.F. Depot, Uxbridge, 11.2.32. C. Hallawell to Air Armament School, Eastchurch, 8.2.32. B. T. Hood to Station H.Q., Hendon, 12.2.32. E. C. Barlow to Station Flight, Duxford, 6.2.32. J. Silvester to H.Q., Wessex Bombing Area, Andover, 11.2.32. E. A. Sullock, A.F.C., to Superintendent of R.A.F. Reserve, Hendon, 12.2.32. H. H. Brookes to No. 29 (F) Sqdn., North Weald, 12.2.32. F. H. Cashmore to H.Q., Coastal Area, Lee-on-Solent, 9.2.32. T. C. Penna to No. 1 Stores Depot, Kidbrooke, 8.2.32. A. F. Lingard to No. 58 (B) Sqdn., Worthy Down, 12.2.32. G. P. Macdonald to No. 25 (F) Sqdn., Hawkinge, 12.2.32.

*Flying Officers*: N. Foster-Packer to No. 35 (B) Sqdn., Bircham Newton, 20.1.32. A. W. Vincent to No. 19 (F) Sqdn, Duxford, 29.1.32. E. E. Noddings to Station Flight, Duxford, 4.2.32. H. P. Wilson to No. 40 (B) Sqdn., Upper Heyford, 4.2.32. R. M. Messiter to Air Armament School, Eastchurch, 3.2.32. G. A. E. Harkness to Home Aircraft Depot, Henlow, 1.2.32. R. C. Higgins to Station H.Q., Duxford, 9.2.32. R. C. Hancock to R.A.F. Depot, Uxbridge, 16.1.32. L. M. Woolveridge to R.A.F. Depot, Uxbridge, 21.1.32. E. M. F. Grundy to R.A.F. Base, Gosport, 8.2.32. A. E. V. Mathias to No. 10 (B) Sqdn., Boscombe Down, 5.2.32. R. H. Cave Penney to R.A.F. Depot, Uxbridge, 21.1.32. G. F. Hales to Air Armament School, Eastchurch, 27.1.32.

*Pilot Officers*: D. R. S. Bader to R.A.F. Depot, Uxbridge, 14.12.31 G. J. S. Chatterton to No. 1 (F) Sqdn., Tangmere, 18.1.32. H. E. Slowley to R.A.F. Depot, Uxbridge, 21.12.31. L. G. Brooks to R.A.F. Depot, Uxbridge, 21.1.32. A. N. Spottiswoode to No. 2 Flying Training School, Digby, 4.2.32.

*Medical Branch*

*Squadron Leaders*: T. C. St. C. Morton to R.A.F. Depot, Uxbridge, 18.1.32, on transfer to Home Estabt. P. C. Livingstone to R.A.F. Depot, Uxbridge, 18.1.32, on transfer to Home Estabt. R. Boog-Watson to No. 5 Flying Training School, 13.2.32, for duty as Med. Officer. E. N. H. Gray to H.Q., Inland Area, 18.1.32, for duty as Med. Officer.

*Flight Lieutenants*: G. J. Hanly to P.M.R.A.F. Hospital, Halton, 1.1.32. J. C. Neely to Station H.Q., Kenley, 12.2.32. J. Kemp to Station H.Q., Northolt, 13.2.32. P. J. McNally to R.A.F. Station, Hawkinge, 12.2.32. C. G. Harold to R.A.F. Base, Calshot, 13.2.32.

*Flying Officer* R. L. Raymond to Med. Training Depot, Halton, 25.1.32.

## R.A.F. SPORT

### Rugby Football

**R.A.F. v. Leicester**

On January 28 the R.A.F. XV suffered a sound defeat from the Leicester team at Leicester, the scores being one placed goal, one penalty goal, and two tries (14 points) to one try (3 points).

### Association Football

**R.A.F. v. Civil Service**

The R.A.F. drew with the Civil Service, 3 goals all, in a good game at Chiswick on February 10. The R.A.F. goals were scored by Turner and Lightfoot (2). The R.A.F. team was:—A.C. Henderson (Central Band); L.A.C. Flynn (Kenley), Sergt. James (Bicester); Cpl. Baldwin (W. Drayton), L.A.C. Hamlett (Mountbatten), Cpl. McPherson (Uxbridge); A.C. Brown (Grantham), Aircraftman Apprentice Lightfoot (Ruislip), Cpl. Turner Uxbridge), L.A.C. Knight (Henlow), A.C. Hickey (Uxbridge).

### BOXING

**Royal Air Force *v.* Cambridge University**

[From a Correspondent]

There was a bright programme of boxing at Henlow on Friday, February 5, when the Royal Air Force met the Light Blues in a series of three-round contests.

**Featherweight**

The Royal Air Force had to provide a deputy for this contest, Pilot Officer Littler being unable to appear. A. C. Blackburn, of Henlow, however, proved to be a good substitute and scored a comfortable points victory over P. J. Macdonald (Magdalene).

**Light-Weight**

The University drew level when J. P. Cowan (St. Catherine's) outpointed Pilot Officer Sissin, Royal Air Force, this year's Wakefield winner. Cowan made Sissin miss repeatedly, and showed a superior defensive style.

**Welter-Weights**

In the first of four contests at this weight, the R.A.F. Champion, Flying Officer Nobleston, had a unique experience in meeting an opponent to go the full three rounds, as he has a wonderful record of knockouts in this class of fighting. G. A. Claydon, of St. Catherine's, however, resolutely refused to get in the way of a knockout, and Nobleston had to be content with a points victory. Flying Officer Slocum gained another point for the Royal Air Force in disposing of W. B. Dunn (Clare) in the first round. Slocum landed repeatedly with his left to the head, and when the referee stopped the fight, Dunn was on the point of collapse. J. R. N. Brown (St. Catherine's) was no match for Flying Officer Calvert, Royal Air Force, in the third welter contest, going down three times in the first round and once in the second. He staged a wonderful come-back in the last round, but Calvert again sent him to the boards with a right to the point. Calvert showed a good style and boxed cleverly with both hands, gaining an easy points verdict. The Royal Air Force went further ahead when Flying Officer Pugh knocked out P. E. M. Holmes (Magdalene) in the first round. Doubling his opponent up with a blow to the body, Pugh landed a heavy right to the point which effectively disposed of the University candidate.

**Middle-Weights**

The contest between Pilot Officer Freeman, Royal Air Force, and G. Burrowes (Caius) was of particular interest, inasmuch as Cambridge scored their second victory. In a slogging bout, Burrowes proved to be easily superior, and the referree stopped the fight in the third round. Pilot Officer MacNair, Royal Air Force, followed up by scoring a first round knockout over A. G. Sharp (Clare). The right arm swing which McNair landed to the point would have felled an ox, and little surprise was occasioned when Sharp failed to rise and had to be carried unconscious from the ring.

**Light-Heavy-Weights**

Flying Officer D. McLean, the R.A.F. and I.S.B.A. champion, was opposed to T. W. Dassenaike (Emmanuel). There was little to choose between the contestants, and it was not till the final round that McLean exerted his superiority and gained a points verdict. The second contest at this weight was quickly over, Pilot Officer O'Hagen, Royal Air Force, going down for the count to a left-hand swing from P. A. Milmo (Trinity) in the first round.

**Heavy-Weight**

In the final bout of the evening, Flying Officer Williams, the R.A.F. Champion, outpointed G. W. G. Lee (Pembroke). The fight was completely spoilt by a series of clinches, and the referee had to separate the contestants frequently. The decision was a popular one, Lee being undoubtedly lucky to escape disqualification for holding. The contest resulted in a win for the Royal Air Force by eight fights to three.

# AIRCRAFT COMPANIES' STOCKS AND SHARES

THE reduction in the Bank Rate has assisted the stock and share markets to retain the more cheerful tendency recently in evidence. On balance for the month a number of popular industrial shares have had a satisfactory rise, but the volume of business has not materially improved, and consequently there has been nothing in the way of a general rally in prices. A steady showing has been made by shares of companies connected with the aircraft and allied industries, which, in a number of cases are beginning to receive more attention in anticipation of the annual reports, due to be issued during the next few weeks. Possibly chief interest has attached to D. Napier, which have lost a further 6d. on the month and are now quoted at 3s. 9d. The passing of the interim dividend some months back naturally prepared the market for some reduction in the dividend from the previous year's 15 per cent., but although the annual report falls to be issued next month no estimates of the dividend are yet current in the market. Even if a setback has occurred in earnings, the company enjoys a strong financial position and can no doubt be expected to take immediate advantage of improved trade conditions. The shares were not quotably affected by the announcement that Mr. H. T. Vane has resigned his position as managing director and chairman of the company. Fairey Aviation have been very steady around 15s. and come in for good support on any reaction. The half-yearly interest on the debentures is payable on March 1. De Havilland were also steady at 15s., but have not been particularly active. On balance for the month Handley Page participating preference have lost 3d. to 10s. 6d. The possibility of a larger dividend may before long draw attention to the shares as it did last March. Rolls-Royce have put on 1s. 3d. to 31s. 3d. In view of the conservative policy invariably followed by the board the market is prepared for a "cut" in the dividend, but there are hopes that 10 per cent. may be forthcoming. Vickers is another share which can be expected to come under dividend hopes before long, for the annual report is usually published in March. On the basis of the previous year's 8 per cent. dividend the yield is not large, but prospects enter largely into the market's valuation of the shares. In view of the conservative policy being followed by the Continental subsidiaries the market is now prepared for a reduction in the Ford Motor dividend from 10 per cent., the rate which has ruled since the public have been interested in the shares. Estimates range from 2½ to 5 per cent. The report is unlikely to be issued until the end of next month. Joseph Lucas have been a better market and recovered 1s. 3d. to 60s., while the Birmingham price for Birmingham Aluminium Casting moved up 1s. to 19s. 6d. At the same centre, James Booth are 3s. 6d. higher at 41s. 6d. on dividend hopes. Imperial Airways have been maintained at 13s. 6d.

In other directions, Dunlop Rubber issues have been moving against holders on dividend fears. Triplex Safety Glass show a rise on balance of 1s. 9d. and have come in for ready support on any reaction to around 30s. British Aluminium have been a stronger market not on final dividend hopes so much as on talk that the general tariff may be of material advantage to the company. In view of the fact that the interim was passed, there is naturally some doubt whether the total dividend will be kept at 10 per cent., the rate which has ruled for some years past. British Oxygen have lost 1s. 3d. to 11s. 3d. on the month on dividend uncertainty, but Brown Brothers were maintained on expectations that the dividend will be maintained. "Shell" participated in the upward move in oil shares earlier in the month, and were not affected by the estimate put forward by a leading firm of stockbrokers that most oil shares will at best not receive more for 1931 than the equivalent of the final dividends paid for the previous year. For 1930 the "Shell" paid a final of 7½ per cent. net. A point of interest has been the marking of business at 24 and 25 in National Flying Services 7 per cent. debentures, the interest on which is being duly paid on March 1. Petters lost 2s. 6d. to 17s. 6d. The interim preference dividend postponed in November last is to be paid, but necessitates drawing on liquid resources.

| Name. | Class. | Nominal Amount of Share. | Last Annual Dividend. % | Current Week's Quotation. |
|---|---|---|---|---|
| Anglo-American Oil .. .. | Deb. | Stk. | 5½ | 97½ |
| Armstrong Siddeley Develop. | Cum. Pref. | £1 | 6½ | 13/1½ |
| Birmingham Aluminium Castg. | Ord. | £1 | 5 | 19/6 |
| Booth (James), 1915 .. .. | Ord. | £1 | 15 | 41/6 |
| Do. do. .. .. | Cum. Pref. | £1 | 7 | 22/- |
| British Aluminium .. .. | Ord. | £1 | 10 | 22/10½ |
| Do. do. .. .. | Cum. Pref. | £1 | 6 | 18/1½ |
| British Celanese .. .. | Ord. | 10/- | Nil | 9/3 |
| British Oxygen .. .. | Ord. | £1 | 8B | 11/3 |
| Do. do. .. .. | Cum.Pref. | £1 | 6½ | 16/3 |
| British Piston Ring .. .. | Ord. | £1 | 10 | 25/- |
| British Thomson-Houston .. | Cum. Pref. | £1 | 7 | 22/6 |
| Brown Brothers .. .. | Ord. | £1 | 10 | 22/6 |
| Do. do. .. .. | Cum. Pref. | £1 | 7½ | 21/3 |
| Dick (W. B.) .. .. .. | Cum. Pref. | £10 | 5 | 112/6 |
| De Havilland Aircraft .. | Ord. | £1 | 5 | 15/- |
| Dunlop Rubber .. .. | Ord. | C | 6 | 10/1½ |
| Do. do. .. .. | "C" Cum.Pref. | 16/- | 10 | 10/3 |
| En-Tout-Cas (Syston) .. .. | Def. Ord. | 1/- | Nil | 1/- |
| Do. do. .. .. | Ptg. Pfd. Ord. | 5/- | 8 | 1/10½ |
| Fairey Aviation .. .. | Ord. | 10/- | 10* | 15/3 |
| Do. do. .. .. | 1st Mt. Deb. | Stk. | 8 | 105 |
| Firth (T.) & John Brown .. | Cum. Pref. | £1 | 6D | 8/6 |
| Do. do. .. | Cum. Pref. | £1 | 5*D | 7/6 |
| Ford Motor (England) .. | Ord. | £1 | 10 | 31/- |
| Fox (Samuel) .. .. .. | Mt. Ptual. Deb. | Stk. | 5 | 72½ |
| Goodyear Tyre & Rubber .. | Deb. | Stk. | 6½ | 97½ |
| Handley Page .. .. .. | Ptg. Pref. | 8/- | 12½ | 10/6 |
| Hoffmann Manufacturing .. | Ord. | £1 | Nil | 15/1½ |
| Do. do. .. | Cum. Pref. | £1 | 7½ | 13/9 |
| Imperial Airways .. .. | Ord. | £1 | 3 | 13/6 |
| Kayser, Ellison .. .. | Ord. | £5 | Nil | 55/- |
| Do. do. .. .. | Cum. Pref. | £5 | 6 | 75/- |
| Lucas (Joseph) .. .. | Ord. | £1 | 20 | 60/- |
| Napier (D.), & Son .. .. | Ord. | 5/- | 15 | 3/9 |
| Do. do. .. .. | Cum. Pref. | £1 | 7½ | 18/9 |
| Do. do. .. .. | Pref. | £1 | 8 | 16/10½ |
| National Flying Services .. | Ord. | 2/- | Nil | -/4½ |
| Petters .. .. .. .. | Ord. | £1 | 6 | 17/6 |
| Do. .. .. .. .. | Cum. Pref. | £1 | 7½ | 17/6 |
| Roe (A.V.) (Cont. by Armstrong-Siddeley Devel., *q.v.*) | Ord. | £1 | — | — |
| Rolls-Royce .. .. .. | Ord. | £1 | 10 | 31/3 |
| Smith (S.) & Sons (M.A.) .. | Def. Ord. | 1/- | Nil | 1/6 |
| Do. do. .. | Ptg. Pfd. Ord. | £1 | 7 | 13/9 |
| Do. do. .. | Cum. Pref. | £1 | 7½ | 15/- |
| Serck Radiators .. .. | Ord. | £1 | 15 | 30/- |
| "Shell" Transport & Trading | Ord. | £1 | 17½* | 42/6 |
| Do. do. .. | Cum. Pref. | £10 | 5 | £9 |
| Triplex Safety Glass .. .. | Ord. | £1 | 10 | 32/6 |
| Vickers .. .. .. .. | Ord. | 6/8 | 8 | 8/6 |
| Do. .. .. .. .. | Cum. Pref. | £1 | 5* | 17/9 |
| Vickers Aviation (Cont. by Vickers, *q.v.*) .. .. .. | — | — | — | — |
| Westland Aircraft (Branch of Petters, *q.v.*) .. .. .. | — | — | — | — |
| Whitehall Electric Investmts. | Cum. Pref. | £1 | 7½ | 21/- |

*Dividend paid tax free. B Rate per annum for nine months. C £1 unit of stock. D Last xd. on March 19, 1931.

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## AERONAUTICAL PATENT SPECIFICATIONS

**(Abbreviations: Cyl. = cylinder; i.c. = internal combustion; m. = motors. The numbers in brackets are those under which the Specification will be printed and abridged, etc.)**

**APPLIED FOR IN 1930**

*Published February 25, 1932*

24,923. Sperry Gyroscope Co., Inc. Direction-maintaining means for dirigible craft. (366,058.)

25,289. W. Messerschmitt. Aircraft. (366,079.)

31,586. H. L. Adams. Parachute apparatus. (366,014.)

37,282. J. K. Lane and Redwing Aircraft Co., Ltd. Shock-absorbing devices for aircraft, etc. (366,205.)

**APPLIED FOR IN 1931**

*Published February 25, 1932*

1,934. F. M. Dainton. Two-stroke-cycle i.c. engines having radial cyls. (366,265.)

10,114. Knorr-Bremse Akt.-Ges., and B. Gruno. Pressure-medium braking and steering-gear for aircraft. (366,344.)

10,268. J. A. Sanders and F. L. Stoot. Aeroplanes. (366,345.)

11,346. Dornier Metallbauten Ges., and C. Dornier. Aircraft wings. (366,356.)

12,624. M. P. Pattist. Device for use on board aircraft for determining drift and ground speed, as also for determining bearing angles. (366,372.)

14,617. M. Leupold. Aeroplanes. (366,390.)

16,532. C. J. Carlotti. Hangars. (366,402.)


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